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ALBINISM, PARTIAL ALBINISM AND POLY-CHROMISM IN HAG-FISHES.

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If hag-fishes are the most primitive of living 'fishes,' it is an interesting circumstance that they have not been known to have differentiated a wide range in coloration. In other groups mottlings and bright colors are the rule rather than the exception, but in hag-fishes blotches of color as well as colorless conditions have not hitherto been described. If, however, we consider that these fishes are, as a group, from relatively deep water, it is not to be wondered at that they have run the gamut of coloration common to deep sea forms — thus, in a range of species they pass from black (*Myxine circifrons* Garman), into dark purples, thence to violets and lavenders, then into "meaningless" grays, sometimes uniformly colored, sometimes shaded. In the latter event the dorsal region is the darkest, the ventral the lightest. In some instances lack of pigmentation in definite regions becomes a rather conspicuous feature: thus the tips of the barbels are often, indeed generally, white, and the mid-ventral as well as the mid-dorsal line in several species is unpigmented. In one case at least (*Homea stouti*) the

lack of pigment in the mid-dorsal line becomes a prominent character of the newly hatched young (larval coloration), Aside from this we have had no detailed knowledge of the coloration of hag-fishes, and we could not, therefore, answer the question whether albinos, common in many and widely separate lines, occur also in this phylum of lowly chordates and whether mottled colors had already been evolved. In the event of mottled colors occurring in a single species one might justly infer that the blacks and violets and grays of this group are in reality but symptoms of a deep-water, or possibly of a nocturnal habit.

In regard to the first of these questions we may now, however, state definitely that true albinos occur among hag-fishes, and that partial albinos are not rare. A perfect albino of *H. burgeri*, Fig. 1, was collected at Misaki, Japan, but it was the only one observed in upward of 800 examples.[1] A specimen of *H. stouti* in part albino, white from snout to gill region, somewhat mottled where the white passed into the purple body color, Fig. 2, had formerly been observed by me at Monterey, Cal. (1899), together with several less perfect cases of the pigmentless condition,— these out of many hundred specimens collected. So one can justly conclude that in the myxinoid line albinism already plays its usual rôle among chordates.

The matter of motley coloring in hag-fishes is also elucidated rather strikingly in the case of a specimen of *H. polytrema* Girard, in excellent condition, which the writer recently received from the neighborhood of Valparaiso, Chile.[2] Fig. 3. The coloration of this species as far as one can determine from a single specimen, is brilliantly mottled with black, ashen, umber and ochre, to a degree which at once causes one to wonder whether this form has not been actually mimicking a murray. Indeed we learn from Dr. Delfin's interesting paper that the name of the fisherman for this hag-fish is the "bearded muræna," indicating

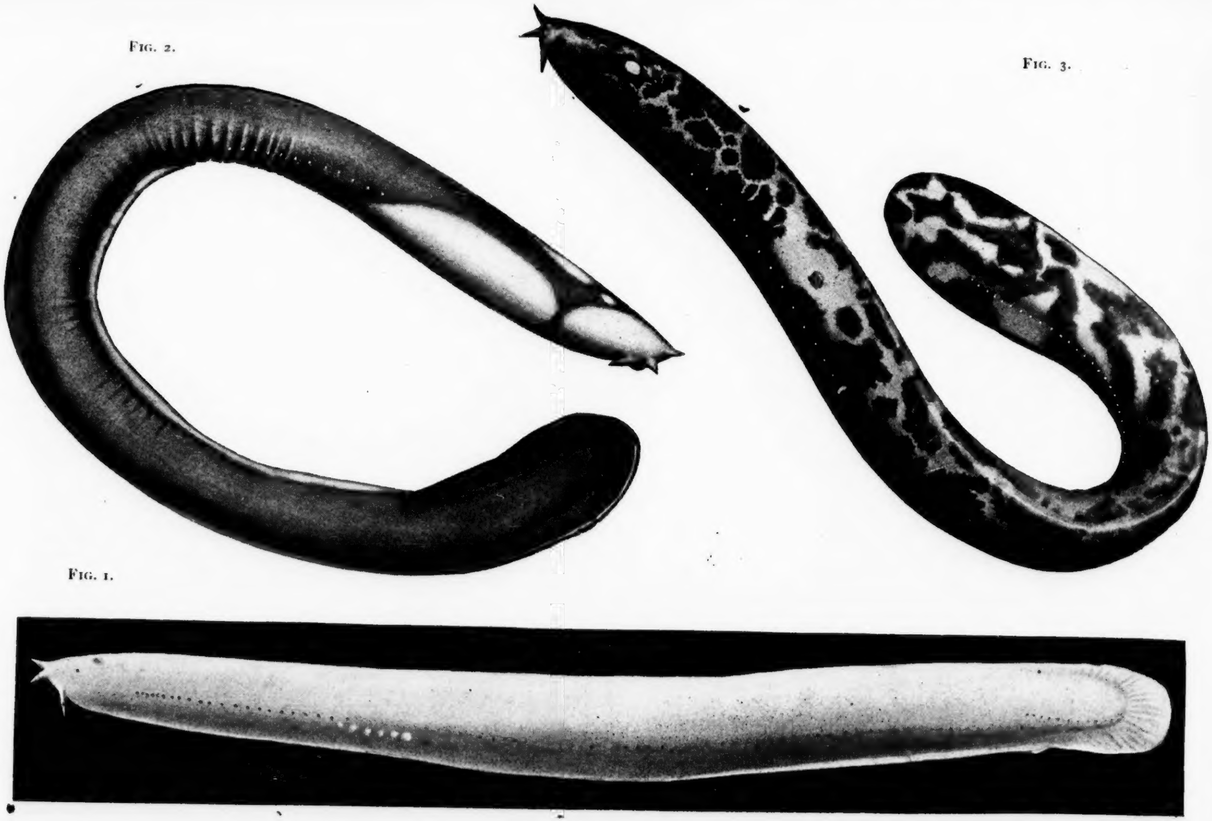
[1] My friend, Mr. Naohidé Yatsu, to whom I am indebted for the figures accompanying the present note, examined this specimen while it was still living and tells me that its color was white, but tinted slightly with yellow, instead of with pink as one would naturally suppose.

[2] For this specimen he is greatly indebted to the kindness of the Chilean ichthyologist, Dr. Federico Delfin, whose observations on the habits of this myxinoid are in many regards the most complete hitherto recorded.

Fig. 2.

Fig. 3.

Fig. 1.



ALBINO AND POLYCHROMIC HAG-FISHES.

Fig. 1. *Homea burgheri*, Misaki, Japan. Fig. 2. *Homea stouti*, Monterey, Cal. Fig. 3. *Homea polytrema*, Valparaiso, Chile.

that the coloration of the present specimen is not abnormal.[1] In this regard, we can, however, derive no light from Girard's description published (1854) in the Chilean expedition report, for he states that his material of Bdellostoma was too poorly preserved to warrant any reference to coloration.

In the matter, accordingly, of the general color of hag-fishes, we can now, I think, reasonably conclude that if one species is provided with definite colors the entire group can hardly be different in this regard from other piscine groups, sharks, chimæroids, teleosts, in which deep sea forms are characteristically monochromic, and shallow water ones motley. And if we accept this conclusion, and it seems to me a sound one, we have still another ground for the belief — by analogy with other groups — that myxinoids are represented at the present day by but a small number of forms, in contrast with their maximum development in species and genera in early times.

[1] In a reference to Wolnitzky (Baldomero), "Coast Fishery of the Province Aconcagua," *Buffalo Exposition* (1901) *Handbook*, *B. polytrema* is referred to as the "black Congrio," although this writer remarks that the name is a misnomer. No note as to coloration is, however, given.

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VARIATION IN LITHOBIUS FORFICATUS.

STEPHEN R. WILLIAMS.

As long ago as 1865, Dr. H. C. Wood in his "Myriapoda of North America" called attention to the great variation in that group and tabulated many variations. I have chosen *Lithobius forficatus*, the most common of the Chilopoda in the eastern part of our country, for a quantitative variation study.

Lithobius forficatus is a cosmopolitan species, found in Europe as well as America. This paper will furnish a place-mode for the species at Cold Spring Harbor, Long Island. Comparisons with place-modes from distant locations will be instructive. Since the variations found are in specific characters such as prosternal teeth, coxal pores, antennal joints and spines we might hope for suggestions as to whether selection in Lithobius is tending in any definite direction? Are the polygons skew in any special way? Is *Lithobius forficatus* a stable or unstable species? Any satisfactory answer to such questions would help our knowledge of the method of origin of species, and in so far advance this, the chief aim of modern biology.

Cold Spring Harbor has a moist climate with abundance of vegetation, a corresponding wealth of insect life and, correlated with these conditions, an abundance of the carnivorous Lithobius. The prevailing species is *L. forficatus*, although in looking over my material I find three specimens of *L. multidentatus* which must have been taken at Cold Spring Harbor. Myriapods of other genera are also common, *Scolopocryptops sexspinosus* and a Geophilus, probably *G. mordax*, represent the Chilopods and Polydesmus, Polyxenus, and some of the Iulidæ the Chilognaths.

The animals were collected during the summers of 1899 and 1900. The greater portion came about equally from a "trap" of mowed yard grass on the upland 300 feet above tide level and from a shaded moist region down within a few feet of highest tide. Here some logs and planks served as traps. The Litho-

bius breed in this latter location, since great numbers of very small white individuals 3 to 8 mm. long are to be found in the hiding places during the months of July and August.

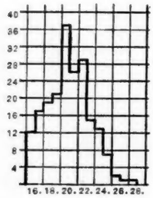

Fig. 1. The length polygon of 200 individuals.

I took the length of 200 individuals, 100 males and 100 females (Fig. 1). The length was measured from the head between the bases of the antennæ to the end of the anal segment — not to the ends of the posterior legs. The polygons were also drawn for the 100 males alone (Fig. 2), for the 100 females (Fig. 3), and for 100 mixed specimens, 51 males and 49 females, which had been selected entirely at random and so with no regard to sex (Fig. 4). On this last 100 all the other determinations were made. The complete data from this last lot are given in Table 9.

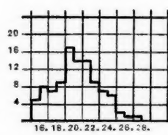

Fig. 2. Length polygon of 100 males.

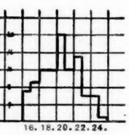

Fig. 3. Length polygon of 100 females.

Because Lithobius grows by moults, only those specimens 16 mm. long or more were measured in order to have a somewhat homogeneous group. They are probably all adults or nearly so. The longest male was 28 mm. long and the longest female was 25 mm. long. There are two apices for the length polygon, the greatest number of individuals (37) falling in the 20 mm. class and the next greatest (29) in the median class, 22 mm. It would take but three individuals to level up the depression at 21 mm. so that the polygon might be considered unimodal. It is skew to the right, due to the rejection of the smaller, younger individuals which would have fallen to the left side of the polygon. The same two classes are the modal classes in the mixed polygon. (Fig. 4) and the polygon for the 100 females, (Fig. 3). The polygon for the 100 males (Fig. 2,) has but one mode at 20 mm.

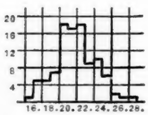

Fig. 4. Length polygon of 100 specimens, 151 males and 49 females.

TABLE 1.

Length in mm.	16	17	18	19	20	21	22	23	24	25	26	27	28
200 indiv.	12	17	19	21	37	26	29	15	13	7	2	1	1
100 males	5	8	7	9	17	14	14	9	7	6	.2	1	1
100 females	7	9	12	12	20	12	15	6	6	1			
100 mixed	1	5	5	7	18	17	18	9	10	6	2	1	1

These data are represented graphically in Figs. 1 to 4.

TABLE 2.

Length Polygons	Type	Mean. P. E. M..	St. Dev. P. E. St. Dev.	Coef. Var.
200 indiv.	1	20 43 ± .12	2.446 ± .083	11.97
100 males	4	20.87 ± .15	2.29 ± .11	10.97
100 females	1	19.96 ± .15	2.245 ± .107	11.25
100 mixed	1	21.41 ± .15	2.35 ± .11	10.99

For the 100 mixed individuals, 49 females and 51 males, counts were made of :

1. The number of prosternal teeth.
2. The number of joints in the antennæ.
3. The number of coxal glands, pits or pores which are found on the coxæ of the last four pairs of legs (the 12th, 13th, 14th, and 15th). These data are given in their entirety in Appendix A.

According to the key for the different species of Lithobius in Bollman's "Myriapods of North America" the number and arrangement of the coxal pores, the spines on the legs, the number of joints of the antennæ and the prolongations of the posterior angles of certain of the dorsal plates are the decisive specific characters. I append an abbreviated key taken from Bollman ('87) for the two species *L. forficatus* and *L. multidentatus*. I intended to include in the data counts of the ocelli also but it was impossible. As Bollman says "the ocelli are distinct or not" and in many cases the fusion was nearly as complete as in Scutigera where there is a close approach to the facetted compound eye.

Posterior angles of the 9th, 11th and 13th dorsal plates produced. Anal feet with a single spine, the penultimate with two. Coxæ unarmed. Coxal pores in a single series. Antennæ more than 30 jointed. Claw of the

female genitalia tripartite. Coxal pores transverse, on 12th coxæ 6–9, on 13th 6–10, on 14th 6–9, on 15th (anal pair) 4–6 pores. Joints of antennæ 33–43. Prosternal teeth 8–12 . . . . *Lithobius forficatus.*
(Coxal pores round in younger specimens.)

Posterior angles of the 6th, 7th, 9th, 11th, and 13th dorsal plates produced. Anal feet with a single spine. Coxæ armed. Coxal pores multiseriate. Joints of antennæ 19–23. Prosternal teeth 14–18. Coxal pores arranged in 3 to 5 series. . . . . *Lithobius multidentatus*
(Specimens 12 mm. long have coxal pores in 2–3 series, those 10 mm. long in 1–2 series and those 5 mm. long have round pores in a single series.)

PROSTERNAL TEETH.

TABLE 4.

Number of teeth	8	9	10	11	12	13	14
Number of individuals	4	4	40	18	25	5	4

This distribution is represented graphically in Figure 5.

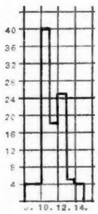

FIG. 5. Polygon of the prosternal teeth shown in Table 4.

The tendency to bilateral symmetry here in the number of teeth is very strong and so gives a bimodal curve with apices at 10 and at 12. But at the ends of the series the bilateral tendency is overcome by the tendency to adhere to the more typical numbers. The tendency to variation, even though it be towards bilaterality, is not so strong as the adherence to the more usual number. There are more individuals with 13 prosternal teeth than with 14 and as many with 9 as with 8.

Figure 6 shows the ventral side of the head of a specimen of *L. multidentatus* with fewer prosternal teeth than *L. forficatus* (Figure 7) has. The number of prosternal teeth is not a good specific criterion as they overlap a great deal in the two species.

JOINTS OF ANTENNÆ.

TABLE 5.

No. joints.	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Right	1	2	2	4	6	6	13	15	12	8	8	8	2	1	0	0	1
Left	3	1	3	2	6	15	9	15	12	8	6	6	1	2	0	0	0

There were 89 individuals possessing antennæ (either one or both) with as many as 34 joints. This minimum was chosen arbitrarily because in Bollman's key *L. forficatus* is said to have

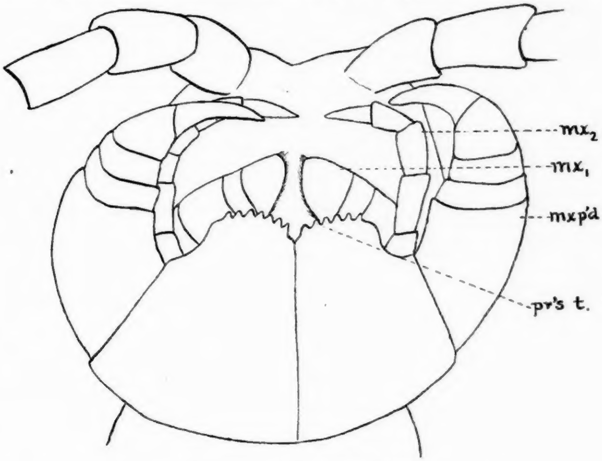

FIG. 6. Ventral view of the head of *L. multidentatus.* × 17.

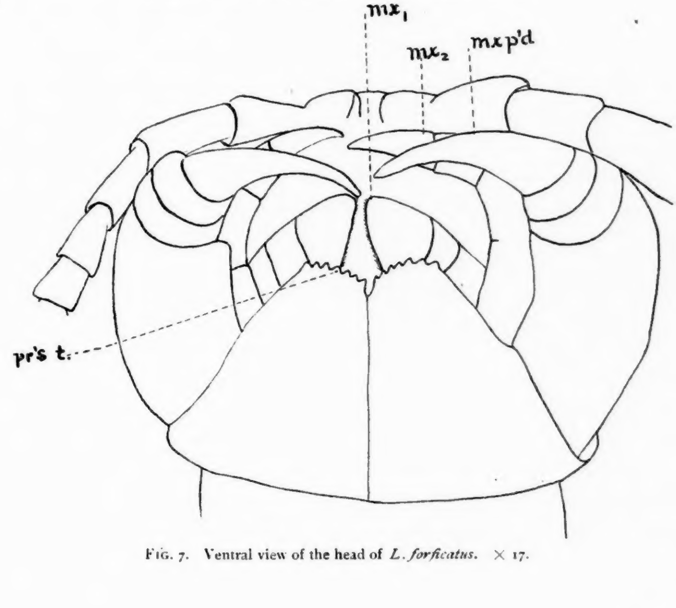

FIG. 7. Ventral view of the head of *L. forficatus.* × 17.

33–43 joints in the antennæ. In the table of data (Table 9) it is shown by underlining that two of the right antennæ counted ended abruptly (Numbers 8 and 50). On the left 33, 50, 57 and 86 had broken ends. The presence of a rounded tip does not necessarily indicate perfectness but possibly merely that regeneration took place at the last moult. Since the antennæ are so liable to injury not much stress can be laid on the polygons (Fig. 8), derived from them. The mode lies at 41 in the right with an average of 41.23. There are equal numbers in classes 39 and 41 on the left side and the average is 40.77.

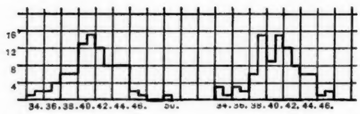

FIG. 8. Polygons of the antennæ, Right and Left.

The number of joints in the antennæ make a good "quick" distinction between *L. forficatus* and *L. multidentatus*. The latter has fewer joints (about as 21 to 43) but the individual joints are longer. This can be seen on the left side of Figures 6 and 7.

COXAL PORES.

In the very young individual the hinder pairs of legs are not yet budded out. The 13th, 14th, and 15th pairs of legs grow in rapid succession, they may possibly all be indicated at the same moult. This increase in the number of legs takes place when the animal is less than 10 mm. long.[1] The 12th pair of legs is the first pair to bear the pits on the coxæ so that these are the oldest pits of the series ontogenetically. The youngest specimens that showed coxal pores at all had two pores, one on each 12th coxa. These were round. They must of course increase in number at the times of moulting until the adult condition is reached. For the condition of the coxal pores in the three hinder pairs of legs in both species under consideration, see Figs. 9 and 10.[2]

[1] Specimens of Lithobius of about this length are often violet in color while those shorter are always white.

[2] Because of the magnification necessary to bring out the pores and the consequent reduced size of field, the 12th pair of coxæ could not be included.

What is the function of these pits on the four posterior pairs of coxæ? Coxal pores are found on many arthropods and are considered to be homologous either with the setigerous glands or with the nephridial openings of Chætopods. In Peripatus, according to Sedgwick ('95) page 19, a series of pairs of glands lie in lateral compartments of the body cavity with ducts opening on the lower surface of the legs. Peripatus has no malpighian tubules but has nephridia like those of the Annulata, which also open at the base of the legs. The slime glands at the base of the oral papillæ may be coxal glands modified for defence. Closed coxal glands occur in adult scorpions, scorpion spiders and many spiders. They are found at the base of one or more pairs of legs. In recently hatched individuals the duct can be traced to the exterior. These animals all possess one or more pairs of malpighian tubules. The "brick-red" gland found in Limulus, whose duct in the

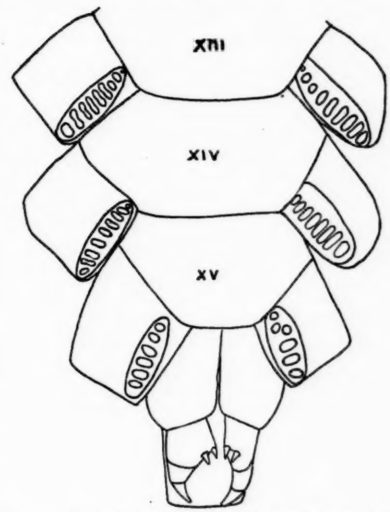

FIG. 9. Ventral view of the last three segments of *L. forficatus* showing coxal pores and female genitalia. × 17.

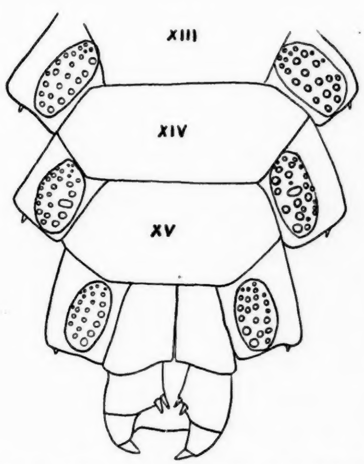

FIG. 10. Ventral view of the last three segments of *L. multidentatus*. × 17.

adult was demonstrated by R. W. Tower ('95, page 471), may correspond to these glands and if it does they are certainly renal in function.

Lithobius possesses malpighian tubules and sections have not demonstrated any connection or passage-way from these coxal glands to the body-cavity. The cup-like depression is lined with columnar gland cells which appear to be in condition to secrete actively. The glands may be secondary characters connected with reproduction for they increase rapidly in number up to adult life and then remain in a condition of comparative equilibrium. There is also the possibility that they secrete a recognition substance.

The number of pores is certainly very variable, as only 19 out of the 100 examined had them arranged in a bilaterally symmetrical fashion.

TABLE 6.

Number of pores	4	5	6	7	8	9	10
12th leg left	–	1	9	45	34	11	–
12th leg right	–	1	15	39	39	5	1
13th leg left	–	–	2	27	49	20	2
13th leg right	–		4	29	47	18	2
14th leg left	–	1	2	41	44	11	1
14th leg right	–	1	9	37	41	12	–
15th leg left	2	31	47	15	3	2	–
15th leg right	2	37	47	13	11	—	—

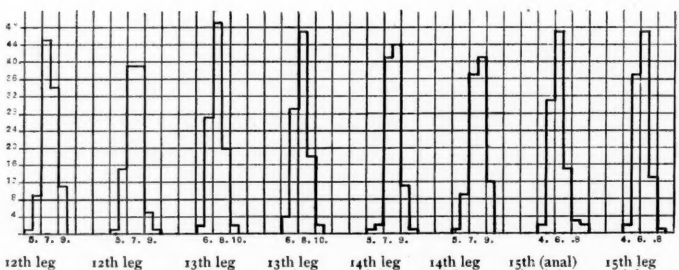

FIG. 11. Polygons of the coxal pores on the 12th–15th pairs of legs of *L. forficatus*.

These distributions of frequencies are illustrated graphically in Figure 11.

TABLE 7.

Coxal pores	Type	Mean. P. E.	Fact. Skew.	St. Dev. P. E.	Coef. Var.
12th leg left	1	7.45 ± .057	+ .004—	.84 ± .04	11.29
12th leg right	4	7.35 ± .058	+ .002—	.865 ± .041	11.7
13th leg left	1	7.93 ± .053	+ .07	.79 ± .038	10.56
13th leg right	1	7.85 ± .056	+ .037	.829 ± .04	9.9
14th leg left	4	7.65 ± .053	— .058	.78 ± .037	11.88
14th leg right	1	7.54 ± .057	— .132	.85 ± .04	11.3
15th leg left	1	5.92 ± .962	+ .49	.91 ± .043	15.4
15th leg right	1	5.74 ± .05	+ .188	.74 ± .935	12.94

What the significance of the fact that the average number of pores is greater on the left side than on the right is I have been unable to determine. The factor of skewness of the left curves also tends to be more to the right even where (14th leg) the curve is skew to the left. There is a similar instance recorded by Bateson, ('94, p. 283), where the abnormality in the number of nipples in the human is higher on the left side than on the right.

Correlations.

TABLE 8.

I. *Coxal pores of the legs correlated.*

Coeff. Corr. or ρ	P. E. Coeff. Corr. or	P. E.
Anal pair legs	.575	± .039
14th pair legs	.69	± .021
13th pair legs	.686	± .029
12th pair legs	.58	± .039

II. *Coxal pores of different legs correlated.*

Anal R. & 12th L.	.427	± .046
Anal R. & 14th R.	.44	± .05
14th R. & 13th R.	.722	± .027
14th L. & 13th L.	.693	± .023
13th R. & 12th R.	.464	± .048

III. *Length correlated with different characters.*

a.	With cox. pores			
		Anal leg R.	.227	± .062
		14th leg R.	.308	± .059
		13th leg R.	.298	± .059
		12th leg R.	.205	± .063
b.	With number of joints in antennae		—.013	± .067
c.	With number of prosternal teeth		.131	± .066

CONCLUSIONS.

1. From the latter part of Table 8 it will be seen that length has little to do with the number of joints in the antennæ. If the — sign were significant it would mean an inverse correlation, the longer the animal the fewer antennal joints. But the probable error is ± .067 so that ρ may as likely as not lie anywhere from —.08 to + .054. There is thus essentially no correlation. You can say, a priori, that the antennæ of the larger, presumably older specimens are more likely to have been broken and to be found regenerating. There is no way of telling a regenerated terminal segment from an original termination.

2. Length of body and number of prosternal teeth have little to do with each other, the coefficient of correlation varying between .065 and .195. I picked out from the data the four individuals with 14 prosternal teeth, the maximum number. Their lengths were 24, 24, 22, and 21 mm. In the four individuals with 8 teeth, the minimum number measured, the lengths were 20, 22, 23 and 23 mm. This tells roughly what the coefficient of correlation tells precisely. In the case of the curve for the prosternal teeth, which is strongly bimodal, the bimodality is due to the tendency towards bilateral symmetry. At the ends of the series this tendency is overcome by the tendency of variations to revert toward or group around the mode. Hence the larger number of individuals with 9 and 13 teeth compared to those with 8 and 14 teeth.

3. The length bears a more decided relation to the number of coxal pores. The number of coxal pores on each of the right legs was correlated in succession with the length. The coeffi-

cients of correlation of the pores of the right side were, according to Table 8: Anal, .227; 14th, .308; 13th, .298 and 12th, .205. That is, the anal and 12th leg coxal pores are more independent of the length of the animal than are those of the 13th and 14th legs. In other words the correlation is less at the ends of a linear series. I had expected the anal pores, the youngest ontogenetically, to vary quite closely with the length of the animal, the fewer pores on the shorter animal and vice-versa. This is found to be true if a group of shorter animals, 6–15 mm. in length be measured. The coefficient of correlation of the pores of the right anal legs with the lengths in a group of 49 young individuals is .88.

4. In the first part of Table 8 are correlated the coxal pores of the pairs of legs, right with left. Here again the correlation is smaller at the ends of the series. The correlation is much closer than it was with the length but the pores of the anal pair have a coefficient of .575 and the 12th of .58 against .686 for the 13th and .69 for the 14th. The order is the same as in the length correlations except that now it is the anal pair of legs which shows the least correlation whereas it was the 12th which corresponded least closely to the length.

I tried also one pair of diagonal cross correlations and some serial correlations with very interesting results. The coefficient of correlation of the coxal pores of the right anal legs and the pores of the 12th legs is .43. That of the anal pores R. with the 12th pores R. is .44. Consequently, diagonal correlation of the ends of the series is nearly as close as the correlation of the terminal members of the series on one side of the animal.

Calculating the correlation of the pores of each leg with the one next it on the right side of the animal there is shown again the difference in closeness of correlation between the ends and the middle of the series. But the closeness of correlation of the 14th R. pores with those of the 13th R. (.722) was so high that I tried the opposite side, the 14th L. with the 13th L. and found not quite as close a relationship but yet one higher than any previous correlation obtained. There is here an unusual case. In a bilaterally symmetrical animal the relation existing between two adjacent segmentally arranged groups of

organs is greater than that existing between the two symmetrical groups of one segment. That is, *the morphological kinship between successive segments is greater than the likeness between the two sides of a segment.*

In trying to trace the ancestral history of any species, resemblances which point toward a related species are valuable. We have these in *Lithobius forficatus* and *L. multidentatus*. The drawings of the two types of coxal pores, Figures 9 and 10, show how the normal condition in *L. forficatus* can be suggested by variations in *L. multidentatus* and *vice versa*. We know that the first condition of the pores in both species is the same, a single row of small round pores. This is probably the ancestral condition. A fusion of two pore rudiments in *L. multidentatus* would give the oblong shape natural in *L. forficatus* and to be seen twice in the drawing of *L. multidentatus*. On the other hand a further constriction of the middle of the long narrow pores of *L. forficatus* (left hand upper coxa) would result in a two rowed condition. How the many rowed condition arises from the single row in L. multidentatus and the phylogeny of coxal pore-patterns in general is a subject for further study. That abnormalities in one species may indicate the normal condition in a related species has been shown by Davenport ('00).

SUMMARY.

1. A place-mode is furnished for *Lithobius forficatus*, for the years 1899 and 1900, at Cold Spring Harbor, Long Island.
2. Length of body has essentially nothing to do with the number of antennal joints in specimens 15 mm. long or more.
3. Length has very little to do with the number of prosternal teeth.
4. Length has some bearing on the number of coxal pores in the adult, the correlation being closer on the 13th and 14th legs than on the 12th or 15th legs.
5. Coxal pores show a greater segmental or serial correlation in the case of the 13th and 14th legs than bilateral symmetry.
6. Variations in the one species of Lithobius point toward the normal condition in the other species under consideration.

In conclusion I wish to express my thanks to Dr. C. B. Davenport for his many kindnesses in directing the work and for criticising the paper.

LITERATURE CITED.

1. BATESON.
'**94**. Materials for the Study of Variation.

2. BOLLMAN, C. H.
'**93**. Myriapoda of North America. Edited by L. M. Underwood. *Bull. U. S. National Museum.* No. 46.

3. DAVENPORT, C. B.
'**99**. Statistical Methods.

4. ——
'**00**. On the Variation of the Statoblasts of Pectinatella. *Am. Nat.* Vol. 34, No. 408.

5. SEDGEWICK, A.
'**95**. Peripatus. *Camb. Nat. Hist.* Vol. 5.

6. TOWER, R. W.
'**95**. The external opening of the "Brick-red" gland in Limulus. *Zool. Anzeiger* Dec. 1, p. 471.

7. WOOD, H. C., Jr.
'**65**. On the Myriapoda of North America. *Trans. Am. Phil. Society* Vol. 13 N. S. Part 2. 137–248. 3 Pls.

Number.	Length mm.	Joints Antenna R.	Joints Antenna L.	Cox. Pores 15 leg R.	Cox. Pores 15 leg L.	Cox. Pores 14 leg R.	Cox. Pores 14 leg L.	Cox. Pores 13 leg R.	Cox. Pores 13 leg L.	Cox. Pores 12 leg R.	Cox. Pores 12 leg L.	Prosternal Teeth R.	Prosternal Teeth L.	Sex.
1	22	41	45	5	5	7	8	8	8	7	7	6	6	♂
2	21	30	45	7	7	8	8	8	8	8	8	6	5	♀
3	21	37	36	6	6	9	9	9	9	8	8	6	7	♀
4	24	38	41	6	5	8	8	8	8	7	7	6	8	♂
5	22	41	39	6	6	8	8	8	8	8	8	5	6	♂
6	26	43	44	5	5	9	8	8	8	8	8	5	5	♂
7	24	45	30	6	6	8	9	9	8	8	7	7	6	♂
8	17	39	43	4	5	6	7	7	7	6	7	5	4	♂
9	22	41	40	6	6	8	7	9	8	8	9	6	6	♀
10	26	38	34	5	5	8	8	8	8	7	7	6	6	♂
11	19	42	41	5	4	7	7	7	7	7	7	6	6	♂
12	24	45	28	7	6	8	8	8	8	8	9	5	5	♀
13	27	44	43	6	6	9	9	9	9	9	8	7	7	♂
14	16	43	41	5	5	6	6	6	6	6	7	5	5	♀
15	21	40	39	7	7	9	8	10	9	8	7	5	5	♀
16	24	40	37	6	6	8	8	8	8	8	7	5	5	♀
17	24	43	42	6	7	7	7	7	8	8	8	6	5	♂
18	20	42	42	6	6	7	7	7	7	7	7	5	5	♂
19	24	42	34	6	6	8	8	9	9	8	8	5	5	♀
20	22	42	42	7	7	9	8	8	8	8	7	6	6	♀
21	18	45	41	5	5	7	7	7	7	7	7	6	6	♂
22	23	38	44	7	9	9	10	9	10	10	9	6	6	♀
23	24	42	24	5	6	6	7	7	8	6	7	7	6	♀
24	22	47	45	5	5	7	7	7	8	8	7	6	7	♂
25	25	25	19	5	5	8	7	8	7	6	6	5	5	♀
26	21	33	39	5	8	8	7	8	8	5	6	5	6	♂
27	25	43	44	6	6	7	8	7	7	8	7	5	5	♂
28	21	41	42	5	5	7	7	8	8	7	7	5	5	♂
29	17	45	28	5	6	7	7	8	8	7	7	5	5	♂
30	25	44	44	6	5	8	7	9	8	8	8	5	5	♂
31	20	39	41	6	6	7	8	7	8	7	7	6	6	♂
32	20	41	32	6	6	8	7	8	8	7	7	6	5	♀
33	19	37	40	6	6	7	7	8	7	7	6	6	6	♀
34	21	40	41	6	6	7	8	8	9	7	7	5	6	♂
35	20	42	42	6	6	8	8	8	9	8	8	6	6	♂
36	24	44	44	6	6	8	8	8	8	8	9	5	5	♂
37	25	43	43	5	5	7	8	8	8	7	9	6	5	♂
38	23	45	39	5	5	7	7	7	7	7	6	6	6	♂
39	21	38	39	6	6	6	7	7	8	7	7	6	6	♀
40	22	24	39	7	6	8	8	9	9	9	9	5	6	♀
41	18	50	47	5	5	7	7	7	7	7	7	5	5	♂
42	22	40	38	7	6	8	8	8	8	7	7	6	5	♀
43	23	38	39	6	6	8	8	8	8	8	8	5	6	♀
44	22	40	40	6	6	8	8	8	8	7	7	6	6	♀
45	21	45	42	5	4	6	7	7	7	7	6	6	5	♂
46	20	35	35	6	7	7	7	7	8	8	8	4	4	♀
47	22	38	12	5	5	7	7	8	9	8	5	5	5	♂
48	21	40	39	5	6	6	7	6	7	7	7	6	6	♂
49	20	42	43	6	6	7	7	8	8	8	8	6	5	♂
50	20	35	45	6	7	8	7	8	9	8	8	5	5	♀

Sex.	Number.	Length, mm.	Joints Antenna R.	Joints Antenna L.	Cox. Pores 15 leg R.	Cox. Pores 15 leg L.	Cox. Pores 14 leg R.	Cox. Pores 14 leg L.	Cox. Pores 13 leg R.	Cox. Pores 13 leg L.	Cox. Pores 12 leg R.	Cox. Pores 12 leg L.	Prosternal Teeth R.	Prosternal Teeth L.
♀	51	19	41	46	6	6	9	9	9	9	8	8	5	5
♀	52	21	43	42	5	5	7	7	7	7	7	7	5	5
♀	53	21	30	43	6	6	9	9	9	9	8	8	6	6
♂	54	24	41	40	4	6	8	7	8	8	8	8	4	5
♂	55	28	37	39	7	7	8	8	10	8	8	8	5	5
♀	56	20	43	41	6	6	7	8	8	8	7	7	6	5
♂	57	23	33	45	5	5	7	8	7	7	7	8	4	4
♀	58	20	40	39	5	5	7	7	7	7	7	8	5	5
♀	59	17	41	40	5	5	7	8	8	8	6	6	6	5
♀	60	20	37	39	6	6	8	8	8	8	8	8	5	5
♂	61	20	40	42	5	5	7	7	7	7	7	7	5	5
♀	62	22	44	42	6	6	8	8	8	8	7	8	7	7
♂	63	22	44	41	6	6	7	8	7	8	7	8	6	6
♀	64	19	46	40	6	6	7	7	7	7	8	7	5	5
♂	65	21	12	16	5	5	8	8	9	8	8	8	6	6
♀	66	18	16	47	6	6	7	7	7	7	7	7	5	5
♀	67	20	40	38	6	7	8	9	8	6	8	9	5	5
♀	68	20	42	44	7	7	8	9	8	8	8	8	6	6
♂	69	22	43	39	7	9	8	9	9	10	7	8	5	5
♂	70	25	36	40	7	7	8	8	8	8	6	7	6	6
♂	71	23	39	38	5	8	8	8	8	8	7	8	5	5
♂	72	21	42	43	5	5	6	6	6	7	6	7	5	5
♀	73	20	34	36	6	6	7	7	8	8	6	6	6	6
♀	74	23	39	30	6	6	6	7	7	7	6	7	5	5
♀	75	23	45	29	8	8	7	8	9	9	9	9	5	5
♂	76	20	33	41	6	6	8	8	9	9	9	8	5	5
♂	77	17	39	38	5	6	7	7	8	7	8	7	5	5
♂	78	21	41	42	5	5	6	8	8	8	8	7	5	5
♂	79	24	46	41	5	6	9	9	9	9	7	8	6	6
♂	80	21	44	34	6	6	8	7	7	7	7	7	6	7
♀	81	22	45	45	6	7	7	7	7	7	7	8	5	5
♀	82	22	42	41	7	7	9	8	8	8	8	8	4	4
♀	83	20	44	43	5	5	7	7	7	8	6	7	5	5
♂	84	18	33	43	5	5	7	8	8	8	7	6	6	5
♂	85	19	44	45	5	5	5	5	6	7	6	7	5	5
♀	86	20	41	36	6	6	8	8	8	8	8	8	6	5
♀	87	22	39	38	6	6	8	8	7	9	8	7	5	5
♀	88	19	42	42	5	6	8	8	8	7	6	7	5	5
♀	89	19	40	41	6	5	8	7	7	8	8	7	5	5
♂	90	22	41	39	5	6	7	7	7	7	7	7	5	5
♀	91	18	40	39	6	6	9	8	9	9	8	9	5	6
♀	92	21	41	40	5	5	8	8	8	8	7	8	6	5
♂	93	23	42	41	5	5	7	7	8	7	6	7	5	4
♀	94	21	32	37	6	6	8	8	8	9	9	9	7	7
♂	95	25	36	38	6	7	7	8	8	9	6	8	6	6
♂	96	22	41	39	6	6	8	7	8	8	8	8	5	4
♀	97	23	41	42	6	7	9	9	9	9	7	7	4	4
♀	98	22	40	40	6	7	8	8	8	8	7	7	6	6
♀	99	20	41	41	7	5	8	9	9	9	7	9	6	6
♂	100	17	40	41	5	5	7	7	7	7	6	6	6	6

TABLE 9.

Data derived from counting antennal joints, prosternal teeth and coxal pores of the mixed lot of *L. forficatus* shown in Figure 4.

ON THE MORPHOLOGICAL AND PHYSIOLOGICAL CLASSIFICATION OF THE CUTANEOUS SENSE ORGANS OF FISHES.

C. JUDSON HERRICK.

In determining the rank and meaning of any given sense organ there are three criteria to which we may appeal. (1) Doubtless the most important is direct introspective knowledge, the psychological criterion. This criterion obviously is not available to us in the study of the senses of the lower animals, where we are shut up to the remaining two. (2) Of these the most important is direct physiological experimentation. The sense organs under consideration are subjected to various types of stimuli under experimental conditions and the reactions noted — the physiological criterion. (3) The structure of the organs frequently permits of inference as to probable function, a method of small value except as controlled by other data — the anatomical criterion.

For over two centuries it has been known that the fishes possess various highly specialized sense organs in the skin, and for over half a century it has been recognized that these belong to two distinct morphological types. The problem of the morphological and physiological significance of these organs has exercised some of the ablest zoölogists during the whole of these periods without, however, any agreement having been reached. The reason for this unsatisfactory condition is not far to seek. Most of these authors have been content with inferences as to function based on studies of the structure of the organs — a perilous course at the best — and few carefully wrought out physiological experiments have been made. By the coöperation of a number of students this condition is now largely remedied and positive conclusions become possible. We shall summarize these conclusions without in this place undertaking to give the evidence for them in detail or to cite authorities, taking up first

the anatomical findings which have laid the foundation historically for the physiological differentiation of these sense organs.

In the skin of fishes there are three types of sensory nerve endings belonging to the cerebro-spinal system, aside from sympathetic nerves of uncertain physiological significance. (1) there are free endings everywhere in the skin, but especially on the lips, barblets and exposed surfaces generally. (2) Sense organs in canals or pits obviously belonging to the lateral line system and termed canal organs and pit organs, or collectively nerve hillocks or neuromasts. (3) Sense organs resembling taste buds of the mouth, lying freely exposed on the surface of the skin, never sunk below the surface, and variously termed flask-shaped organs, end-buds, terminal buds, etc.

The nerves which end free, those of the first type, usually lose their medullary sheaths some distance below the skin and have sometimes been overlooked. Merkel, for instance, in his great monograph denies the presence of these endings in the skin of fishes. Recent students of nerve components have shown that the nerves of this type are anatomically distinct from those for both the other types of sense organs for their entire extent, in all cases being provided with separate ganglia and entering the brain by distinct roots. In the trunk region these "general cutaneous" nerves make up the greater part of the dorsal spinal roots and terminate in the dorsal horns; in the head they enter by the V, X and sometimes by the IX pairs of cranial nerves and all terminate in the funicular nucleus or the gray matter associated with the spinal V tract, all morphological equivalents of the dorsal horns of the spinal cord. Morphologically the general cutaneous system of nerves is a well defined unit. Physiologically its function is unquestionably in the main tactile. Practically all parts of the body are sensitive to touch and are reached by these nerves, whether they are supplied by other types of sensory nerves or not. The more acute the tactile sensibility, the more rich the innervation by fibers of this system.

The differentiation of the sense organs of the second and third types has proven very difficult, for the reason that rows of undoubted lateral line organs which are certainly homologous

appear in one species as canal organs, in another as pit organs and in still another as naked sense organs, and the separation of the latter from the terminal buds of the third type is often a matter of difficulty. This has led many of the students of these organs to deny the validity of the distinction between neuromasts and terminal buds, classing both as variants of one type.

In 1870 Schulze discovered that the neuromasts, whether enclosed within canals or exposed upon the surface, are characterized by the presence of specific sensory cells, the pear cells or hair cells, which extend only part way through the sensory epithelium, while the specific sensory cells of the terminal buds, like those of taste buds, extend from the external to internal limiting membrane of the epithelium. This has been generally confirmed and receives further support and interpretation from the recent demonstration that neuromasts and terminal buds receive distinct and strictly characteristic innervation.

All neuromasts, whether canal organs, pit organs or naked organs, are innervated by fibers which are separable from all other types of nerve fibers, with separate ganglia and roots, and all of which terminate in the tuberculum acusticum or in the cerebellum. The sense organs of the internal ear have the same general structure as the neuromasts of the skin and are likewise innervated from the tuberculum acusticum, so that the whole system is termed the acustico-lateral system of nerves and sense organs. The tuberculum acusticum and its derivative, the cerebellum, are morphologically intimately related to the general cutaneous centers of the dorsal horn, and the whole acustico-lateral system is in all probability phylogenetically derived from the general cutaneous system.

This probability is strengthened by the results of recent physiological experiments upon this system. The lateral line system of fishes as a whole is undoubtedly concerned in the maintenance of bodily equilibrium, and the method of stimulation here is closely similar to that of ordinary tactile nerves, and doubtless derived from it. The function of orientation in space is especially localized in the semicircular canals of the internal ear, of like phylogenetic origin with the lateral line canals, and this part of the system persists in all terrestrial vertebrates.

Parker has also shown that the lateral line organs of fishes are sensitive to mechanical jars of low frequency. This again is closely related to the tactile function and has doubtless given rise phylogenetically to the power of perceiving rhythmic vibrations of higher frequency, viz., hearing, a part of the sense organs of the acustico-lateral system within the internal ear having been set apart for this function in the course of vertebrate evolution.

Having now a morphological criterion for defining the cutaneous sense organs belonging to the lateral line system, it may be stated briefly that all other specialized cutaneous sense organs of fishes at present known may be grouped with the taste buds of the buccal cavity both on the basis of their structure and of their innervation. The nerve supply of all of these organs is now known to be from a system of nerves distinct for their entire extent from those previously considered, but intimately related centrally to the sensory nerves from visceral surfaces in general. This is known to students of nerve components as the communis system of nerves and sense organs, because its fibers all end centrally in the gray matter connected with the fasciculus communis (= f. solitarius of human anatomy).

This system of nerves, like the acustico-lateralis, is well developed in certain cranial nerves only, and, as the latter system is supposed to have evolved from the general cutaneous system, so the communis system has probably been differentiated from the general visceral sensory nerves of the trunk. Peripherally it is easy to distinguish the unspecialized component of this system from that which is distributed to special sense organs; but centrally this is much more difficult. This, however, I think I have accomplished in part at least in the case of Ameiurus. At any rate, the chief ascending gustatory path in these fishes is clearly separable from all other reflex paths from the primary communis centers.

No important distinction can be drawn either in structure or in innervation between the terminal buds of the outer skin and the taste buds of the mouth, and to complete our argument it remains to show whether these sense organs are similar in function also. This has now been accomplished. In July, 1902,

I presented before the American Association for the Advancement of Science at the Pittsburg meeting the report of certain experiments made upon the common cat fish, Ameiurus, which go to show that this animal actually tastes with the terminal buds known to be freely distributed over the body surfaces and especially on the barblets. Since that report I have extended these observations upon a number of marine fishes, particularly the gadoids, and the report upon this work is now in press in the *Bulletin of the U. S. Fish Commission.*

It may be regarded as established that fishes which possess terminal buds in the outer skin taste by means of these organs and habitually find their food by their means, while fishes which lack these organs in the skin have the sense of taste confined to the mouth. The delicacy of the sense of taste in the skin is directly proportional to the number of terminal buds in the areas in question. Numerous unrelated types of bony fishes from the siluroids to the gadoids which possess terminal buds have developed specially modified organs to carry the buds and increase their efficiency. These organs may take the form of barblets or of free filiform fin rays and the free rays of the pelvic and dorsal fins of some gadoid fishes are thus explained.

The results of this examination may be summarized in the following form:

I. Organs of the general cutaneous system. Free nerve endings distributed over the general body surface in all vertebrates. Innervation by general cutaneous nerves; primary centers, dorsal horns of spinal cord and homologous centers of oblongata. Function, touch.

II. Organs of the acustico-lateral system. Peripheral organs, neuromasts, or special sense organs with hair cells among indifferent supporting cells, the former extending only part way through the sensory epithelium. Typically arranged in lines on various parts of the body according to a tolerably definite pattern whose details are, however, exceedingly variable. The internal ear is a specialized part of this system. Innervation by the acustico-lateralis nerves; primary centers tuberculum acusticum and cerebellum. Neuromasts may assume one or several of the following forms in a given fish:

1. Canal organs, regularly arranged in canals lying in the dermis or dermal bones and communicating by means of pores at frequent intervals with the surrounding water. Function, perception of mechanical jars or slow irregular vibrations and the maintenance of bodily orientation. Occur in nearly all fishes.

2. Pit organs. Similar to the last, but each organ sunk in a separate pit which opens to the surface by a pore. Usually regularly arranged in lines which are closely related to the canals and which may replace the canals. Function unknown, but probably similar to the last. The pits in which these organs are placed may become very shallow or disappear altogether, the organ becoming superficial, with no apparent change otherwise. Occur in most ganoids and teleosts and sometimes (perhaps generally) in elasmobranchs.
3. Small pit organs. Similar to the last, but smaller and always in deep pits. Not arranged in definite patterns, but irregularly distributed over the skin. Known only in siluroid fishes.
4. Ampullæ. Organs similar in plan to pit organs, lying at the bottom of long slender tubes opening by pores at the surface of the skin, the pores scattered over the head, but the inner ends of the ampullæ grouped in definite clusters. Occur only in elasmobranchs. Function unknown.
5. Vesicles of Savi. Closed vesicles, found only in the torpedoes.
6. Cristæ acusticæ. Found in the semicircular canals of all vertebrates. Function equilibration (reaction to rotary movements).
7. Maculæ acusticæ. Found in the sacculus and utriculus of all vertebrates. Function equilibration (reaction to translatory movements, and static sense ?) and hearing (?).
8. Papilla acustica basilaris. The essential nervous part of the organ of Corti. Function hearing. Found only in vertebrates above the fishes.

III. Organs of the communis system. Peripheral organs are special sense organs with the specific sensory cells extending through the whole thickness of the sensory epithelium; organ generally resting on a raised papilla of the dermis. Present in the mouth of most vertebrates and in the outer skin of some ganoid and teleostean fishes. Innervation by communis nerves; primary centers gray matter associated with the fasciculus communis (f. solitarius), in fishes the vagal and facial lobes. Function taste. There are recognized two forms with no important differences other than position.

1. Taste buds, within the mouth.
2. Terminal buds, in the outer skin, often on barblets or other specialized organs for their reception.

THE COMPOUND EYES OF MACHILIS.[1]

FRANCES SEATON.

THIS study was made from the eyes of *Machilis variabilis*.[2] This insect is found in great numbers on the under surface of stones which lie near the water's edge at the bottom of Fall Creek gorge, Ithaca, N. Y.

During the last of June, when the first trips for collecting these insects were made, they were found to be of two different sizes; but in August only a few of the small ones were met with.

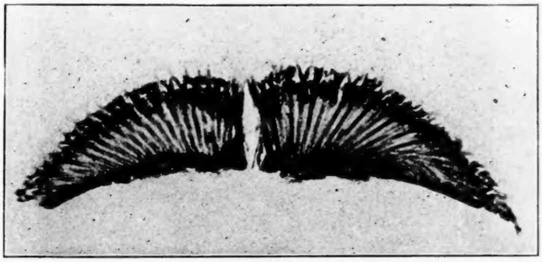

FIG. 1. A vertical section through the two compound eyes, showing their appearance before the pigment is removed.

Whether this difference in size corresponds to a difference in sex, or whether the larger ones were some that were hatched during the previous autumn and had survived the winter, was not ascertained.

In June and July, the exuviæ were abundant on the stones, but in August so few of these were found that it would seem as if these insects must reach the adult stage during the latter part of the summer. At this time also, the largest insects measured 1 cm. in length, excluding the antennæ and caudal filaments.

Early morning proved the best time for collecting Machilis.

[1] Contribution from the Entomological Laboratory of Cornell University.

[2] Identified by Mr. A. D. MacGillivary.

Before ten o'clock, particularly if the mornings were damp or cloudy, they were so plentiful that as many as thirty have been captured within an hour. Toward noon as the sun neared the zenith so that its rays reached the bottom of the gorge, I have seldom found more than half a dozen specimens, and that too, in the same place where, perhaps on the following morning they have appeared as abundant as ever. This has happened so often that it has led me to believe that those creatures do not enjoy much heat and to escape it, either go farther from the surface or seek stones in a more sheltered place.

Machilis were generally found with the body, antennæ and

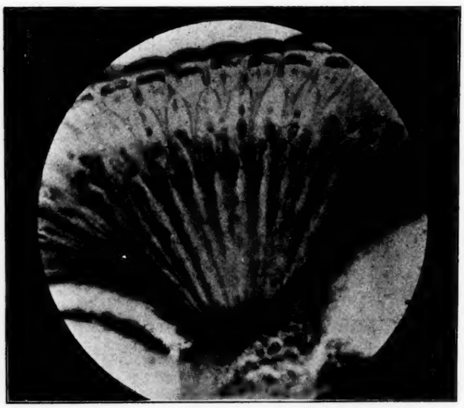

FIG. 2. A vertical section through one compound eye, depigmented and stained.

caudal filaments lying flat against the under surface of the stone. Occasionally the posterior end of the body was raised so that the appendages of the last two and sometimes of the last three segments were raised above the ground, giving the animal an alert appearance. Unless touched, they seldom offered to move, even after the vial used in capturing them, was placed over them. They appear to be sluggish, depending upon their protective coloring as a means of escape from their enemies.

During the summer they have been kept in the laboratory in bottles containing pieces of softened, partially decayed wood upon which they have been seen feeding. Those kept in this way

moulted every seven days though no one insect lived longer than three weeks.

Methods.—This study was made entirely from serial sections. Some of the sections were cut five microns thick but owing to the difficulty of obtaining such thin sections through the chitin, the greater part of the material was cut ten microns thick.

In preparing the eyes, the animals were first killed by being dropped into hot water after which the heads were placed in the fixing reagent. Before the heads were cut off, the antennæ, palpi and as much as possible of the pronotum were removed since it was found that these parts, if left on the head, interferred with the process of imbedding and cutting. The removal of these parts had to be done with great care for the pressure of the hand in holding the animal often caused a distortion of the parts of the eye thus ruining the material for study.

Of the many different fixing reagents tried the best results were obtained with Flemming's fluid, Picro-sulphuric acid, and platino-aceto formaldehyde. The eyes were cut in paraffin after which they were depigmented and stained on the slide. For removing the pigment, nitric acid, caustic potash, and peroxide of hydrogen were each tried, but the last proved to be the most satisfactory.

The stains used were Heidenhain's iron hæmatoxylin, borax carmine and Delafield's hæmatoxylin. The first was often followed by orange G. For staining nerve fibres, methelyn blue was used by injection and immersion. The method used was that given by Huber in the *Journal of Applied Microscopy*, April, '98. The results were not at all satisfactory, owing to the great amount of pigment in the eyes, which concealed all trace of the nerves. In addition to methelyn blue, Kenyon's method for the brain of the bee (*Journal of Comparative Neurology*, '96) was also tried and although this brought out beautifully the structure of the optic ganglia and the nerves proximad of the basement membrane, the eye was so uniformly stained that a definite statement as to which cells are the nerve-end cells can not be made.

The external appearance. — The two compound eyes occupy the entire cephalo-dorsal part of the head, coalescing on the epicranial suture for a distance of 2 mm. Each eye is almost

circular in outline, the diameter from the anterior to the posterior margin being slightly greater than that from the dorsal to the ventral margin.

The eyes appear light green in the centre with a peripheral band of reddish brown.

The corneal cuticle. — The corneal cuticle, a transparent continuation of the body cuticle, is divided into facets which are, with a few exceptions on the periphery of the eye, uniformly hexagonal and of the same size (Fig. 3 a). Each eye contains between 450 and 525 facets. The facets have a maximum width of $23\frac{1}{2}$ microns between their parallel faces and $25\frac{5}{8}$ microns between opposite angles (Fig. 3 a).

The corneal cuticle differs somewhat in thickness in different individuals, reaching a maximum in those insects about ready to moult. The line of separation between the old and the newly formed cuticle is very distinct. This, in individuals about to moult is caused by the fact that the former is more deeply staining than the latter (Fig. 3). The maximum thickness of the cuticle at the centre of each facet is nine and one third microns, while at the periphery it is but seven microns.

The corneal hypodermis. — Proximad of the corneal cuticle and separating it from the cone-cells is the corneal hypodermis — a layer of well differentiated cells and one of considerable thickness (Fig. 3). There are two hypodermal cells beneath each facet. The distal surface of each pair of hypodermal cells is flat and hexagonal in outline (Fig. 3 b). This outline coincides exactly with that of the corresponding facet.

Extending across the distal surface of each pair of cells and perpendicular to two opposite sides of their hexagonal outline is a straight deeply staining line which marks the separation of the two cells. (Fig. 3 b). These lines are not all strictly parallel.

Proximad, the hypodermal cells become considerably smaller, having a width at their proximal end equal to that of the underlying cone which is 6 microns less than the width of the distal surface of the hypodermal cells. The proximal surface of each pair of cells is concave. (Fig. 3.)

The nuclei of the hypodermal cells are large and deeply staining. In transverse sections through the distal end of these cells

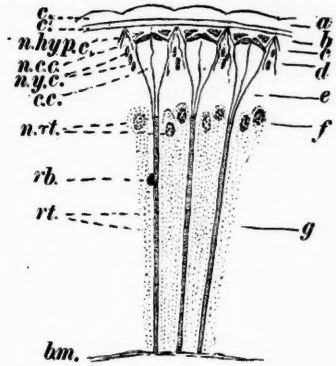

FIG. 3.

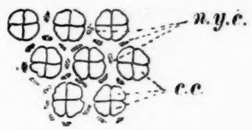

FIG. 3d.

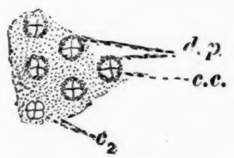

FIG. 3e.

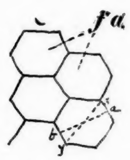

FIG. 3a.

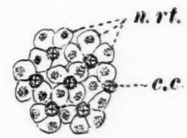

FIG. 3f.

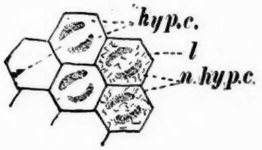

FIG. 3b.

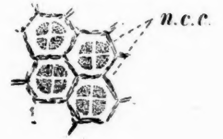

FIG. 3c.

FIG. 3g.

PLATE I.

FIG. 3. A vertical section through three ommatidia of the eye of an insect about ready to moult. The ommatidia have been depigmented and stained.

FIG. 3a. A transverse section through *a*, Figure 3.

FIG. 3b. A transverse section through *b*, Figure 3.

FIG. 3c. A transverse section through *c*, Figure 3.

FIG. 3d. A transverse section through *d*, Figure 3.

FIG. 3e. A transverse section through *e*, Figure 3.

FIG. 3f. A transverse section through *f*, Figure 3.

FIG. 3g. A transverse section through *g*, Figure 3.

the nuclei are semi-elliptical, lying with their long axes parallel to the line separating the two cells. (Fig. 3 b.)

In Machilis maritima, Oudemans ('87) describes four hypodermal cells, but I am sure that there are but two in Machilis variabilis. As Oudemans figures only a longitudinal section of the ommatidia, it may be that he has made an error in observation on this point, for in such a section, two cells present the same appearance as four.

The cone-cells. — In each ommatidium, proximad of the two hypodermal cells, lie four long cone-cells (Fig. 3, *c. c.*) These cells are in close contact along their entire axial surface, forming a cone forty-five microns long with a diameter of seventeen microns at its base or distal end.

At its proximal end the cone is about two and one third microns wide. Although these four cone-cells are closely applied along their axial surfaces, yet their intercellular walls are distinct in all transverse sections of the cone from its base to its proximal end (Fig. 3 d and 3 e).

At the extreme distal end of the cone, lie the granular and deeply staining nuclei of its four cells, (Fig. 3, *n. c. c.*) In transverse sections through these nuclei, each is seen to have the same triangular form and size as that of the cells to which it belongs, thus entirely filling its distal end. (Fig. 3 c.) In longitudinal sections, these cone-cell nuclei appear to have their greatest thickness over the centre of the cone and gradually diminish in thickness toward the periphery. (Fig. 3, *n. c. c.*)

The convex distal surface of these cone-cell nuclei fits into the depression on the proximal surface of the two hypodermal cells. (Fig. 3.)

Whatever the substance of the cone cells may be, it is but slightly affected by dyes. In most preparations it appears absolutely unaffected by them, remaining a perfectly hyaline structure.

The distal pigment. — Surrounding the posterior two thirds of each cone, is a sheath of pigment which appears black in masses, but whose separate large round granules are maroon in color. (Figs. 3 e, and 7.) Outside of this thin sheath of black pigment and separating the cones of the different ommatidia, is a brown-

ish yellow pigment. The cells containing this last pigment extend from a short distance distad of the proximal end of the cones up between the cones and hypodermal cells to the corneal cuticle to which they appear to be attached. (Fig. 3.) The nuclei of these cells lie between the outer ends of the cone-cells (Fig. 3, *n. y. c.*) In a transverse section through the cone, just proximad of the cone-cell nuclei, the nuclei of these yellow pigment cells appear arranged in a circle around each cone (Fig. 3 d). As these nuclei lie at different levels in the eye, their exact number is difficult to determine. Not less than eight have been counted and in some sections, as many as ten or twelve, so that each cone is surrounded by at least three yellow cells and possibly as many as six.

It may be possible that these yellow cells constitute an iris tapetum as in the cabbage butterfly; or they may contain a pigment that acts as such, as in the Dragon fly. (Exner '91.)

In transverse sections through the proximal half of the cones, the black pigment mentioned before occupies a narrow ring around each cone from which it is separated by the peripheral cell wall. (Fig. 3 e.) Outside of this ring of black pigment and filling up the interstices between the cones, lies the brownish yellow pigment. (Fig. 3 e.) It seems probable from both transverse and longitudinal sections that the two kinds of pigment which surround each cone represent two distinct circles of cells, although no nuclei have been found in the narrow area occupied by the black pigment.

Although eyes have been examined from insects which have been kept for three hours in the dark previous to killing, as well as eyes from other insects which have been kept in the light, for an equal length of time, no change in the position of the black or "iris" (Exner) pigment was noticed.

The rhabdoms.—The rhabdoms are the long, rod-like structures which lie between the proximal ends of the cones and the basement membrane (Fig. 3). They occupy about two thirds the entire depth of the ommatidia. At its distal end each rhabdom is equal in width to the proximal end of the cone against which it presses (Figs. 2, 3, and 5). Proximad, the rhabdoms taper slightly until at the basement membrane they are only one

micron in width. The rhabdoms are fluted, having in transverse sections the form of a seven-pointed star (Figs. 3 g, and 7).

In sections from which the pigment has not been removed, the rhabdoms appear as perfectly hyaline structures, while in depigmented and stained sections, with the exception of a small central core, they invariably appear non-granular and deeply staining. (Fig. 3, and 2). Thus the rhabdoms present a decided contrast to their cones which are but slightly affected by dyes, if at all.

There has been no indication in any of the sections that the rhabdoms consist of seven parts or rhabdomeres, except that in cross section they appeared as seven pointed stars. (Figs. 7 and 8.)

In many longitudinal sections they often have a peculiar beaded, or sometimes a corkscrew appearance. (Fig. 9.) This peculiarity has been noticed in sections so differently treated that, at first, it seemed as if it must be due to the presence of nerve fibres in the rhabdoms but it now seems that it is probably an artifact.

That the cones and rhabdoms are in Machilis distinct and separate structures, is evident for three reasons: — first, the rhabdoms always appear as deeply staining structures, while the cones do not; second, in transverse sections the cones appear circular in outline and divided into four parts or cells while the rhabdoms invariably have the form of a seven-pointed star; third, in longitudinal sections there is always a distinct transverse line where the cone-cells end and the rhabdoms begin. (Figs. 2 and 3.) Then, too, in many sections, the cones appear partly broken away from the rhabdoms at this point and whenever the cones were entirely separated from the rhabdoms, the break invariably occurred at this particular point. (Fig. 5.)

This is a very different condition from that which exists in the lobster's eyes as described by Parker ('90), where the four cone-cells are continued as fibers outside of the rhabdom to the basement membrane. It also differs materially from the condition found in the eyes of Mantis (Patten '86), where the cone-cells extend to the basement membrane through the centre of each ommatidium, there being no distinction between cone-cells and rhabdom.

The retinulæ.—In specimens which have not been depigmented the rhabdoms are surrounded throughout their entire length, by a thin sheath of reddish brown pigment. (Fig. 9.) In cross sections, this pigment is seen to extend up close to each rhabdom, filling the spaces between its seven points (Fig. 8.) In longitudinal sections this narrow area of reddish brown pig-

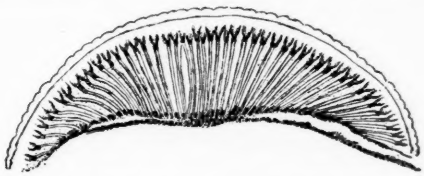

FIG. 4. A vertical section through the two compound eyes before pigment was removed; camera lucida drawing.

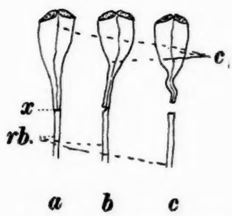

FIG. 5. A vertical section the cones and rhabdomes of three adjacent ommatidia; a, cone and rhabdom in close connection at the point x; b, cone partly separated from the rhabdom; c, cone and rhabdom entirely separated. camera lucida drawing.

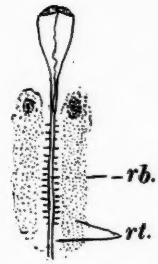

FIG. 6. A vertical section through an ommatidium which has been depigmented and stained, showing the fine horizontal lines which cross the narrow pigmented area surrounding the rhabdom.

ment surrounding the rhabdoms, appears of the same width, and as if it might be continuous with the thin sheath of black distal pigment which surrounds the cone-cells. (Fig. 7.)

In transverse sections of eyes that have been depigmented and stained, the narrow area immediately surrounding the rhabdom, which was before filled with pigment, now appears as a clear non-staining area and across it extend many fine lines from the rhabdom (Fig. 7). Outside of this, the area which before was faintly granular, now appears as a granular, deeply staining area whose outer edge is divided into seven distinct parts. (Figs. 3 g and 7.) Thus in transverse sections through

the proximal half of the eyes, the ommatidia appear as many rosette-like figures which lie so close together that there can be little space between them in eyes. (Fig. 3 g). Each rosette-like figure has in its centre the star-like, deeply staining rhabdom which is surrounded by a narrow hyaline area. Outside of the latter is the deeply-staining granular area whose outer margin shows a distinct division into seven parts. (Fig. 7.)

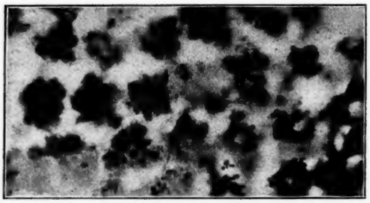

FIG. 7. A transverse section, showing the rosette-like appearance of the rhabdomes and retinulæ, depigmented and stained.

In many longitudinal sections of depigmented and stained eyes, the narrow hyaline area surrounding the rhabdoms, can be seen with a high power, to be crossed at regular intervals by many very fine lines. (Fig. 6.)

Whether the two areas surrounding each rhabdom represent two distinct circles of cells, the inner — the retinulae proper — and the outer,— accessory cells, — or whether these two areas are two parts of a single whorl of cells is difficult to determine. It seems probable, however, that since no nuclei have been seen in the inner area, we have in each ommatidium a single whorl of seven cells, the retinulæ, surrounding each rhabdom. These seven retinulæ are of uniform size and have the pigment massed on their axial border. The number of retinulæ differs from that in Machilis maritima, where Oudemans ('87) described six.

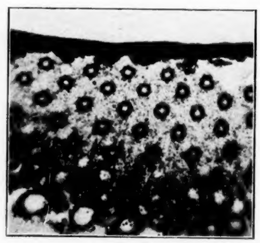

FIG. 8. A transverse section through the eye showing the rhabdomes and pigment.

In longitudinal sections of the ommatidia, the seven retinulæ are seen to extend slightly distad of the proximal end of the cone-cells, where each is considerably enlarged to accommodate

its large nucleus. (Fig. 3.) The nuclei of the retinulæ do not all lie in the same plane. (Fig. 2.)

In addition to the pigment along the axial border of the retinulæ each contains considerable pigment in its proximal end so that in longitudinal sections of the eyes, this appears as a narrow band of pigment distad of the basement membrane. (Fig. 1.)

FIG. 9. A somewhat oblique section showing the narrow area proximal of the basement membrane across which the nerve fibers pass from the optis ganglia to the ommatidia.

Since there is in Machilis no shifting of the iris pigment and since the rhabdoms are of uniform width, the insect, has according to Exner ('91) day eyes with apposed images.

The nerves.— Proximad of the basement membrane, lying between it and the nerve cell sheath of the optic ganglia, is a narrow area containing hundreds of minute nerve fibers which enter the eye through the basement membrane. (Fig. 9.) I am unable to say which cells of the ommatidia the nerves enter.

Abbreviations employed in the figures.

c and c'.	corneal cuticle.	*n. rt.*	nuclei of retinulæ.
hyp.	corneal hypodermis.	*rb.*	rhabdom.
n. hyp. c.	nuclei of hypodermal cells.	*b. m.*	basement membrane.
c. c.	cone-cells.	*d. p.*	distal pigment.
n. c. c.	nuclei of cone-cells.	*l.*	line of separation between hypodermal cells.
n. y. c.	nuclei of yellow cells.		
rt.	retinulæ.	*fa.*	facets.

SYNOPSIS OF NORTH AMERICAN INVERTEBRATES.

XIV. Part IV. The Scyphomedusæ.

CHAS. W. HARGITT.

The following synopsis is a continuation of that upon Hydromedusæ which appeared as XIV of the *American Naturalist* series, during April, May and July, 1901.

As in the preceding parts, while depending largely upon my own records of the Scyphomedusæ, I have at the same time drawn freely upon the literature wherever found, but chiefly Hæckel's "System der Medusen" and to a less extent Mayer's numerous papers. (*Bull. Mus. Comp. Zoöl.*) Fewkes papers, chiefly of the same series, including also L. Agassiz, "*Contr. Nat. Hist. United States*," 1862, and A. Agassiz' "Catalog N. A. Acalephæ," 1865.

In only a few cases has any attempt been made to present accounts of the synonymy of the several species, and then only so much as might serve to obviate ambiguity.

In general form, habit, structure and distribution the Scyphomedusæ have much in common with the Hydromedusæ and probably sustain a more intimate relation to them than to any other cœlenterate Class.

They may however be somewhat sharply distinguished by the following characters:

1. Absence of a true velum. The velarium of the Cubomedusæ has important structural differences, though doubtless serving an identical function.
2. Sense organs when present are modified tentacles, variously designated as tentaculocysts, rhopalia, etc.
3. Entodermic origin of sexual products.

In development there is general correspondence between this and the preceding Class. In some the medusa arises by direct

(hypogenic), development from the egg; while in others, and by far the larger number, development is indirect (metagenic), exhibiting perfectly evident alternation of generations; in this case however, involving a distinct metamorphosis, the polyp giving rise to a free-swimming ephyra which is in turn transformed directly into a medusa. It should also be noted that asexual budding is, unlike that of the former class, by the transverse fission of the polyp body into a series of disks which become free as ephyræ, as already noted. Direct asexual budding from medusoid organs, common in many Hydromedusæ, is unknown among the Scyphomedusæ.

SYNOPSIS OF THE ORDERS.

I. STAUROMEDUSÆ. Scyphomedusæ with vasiform or sub-conical umbrella. In some cases sedentary, attached by an aboral peduncle or stalk. Wholly devoid of sensory organs, but with eight tentacles or tentacular organs which serve as anchors. Stomach with four wide gastric pouches which communicate with a marginal canal. Gonads in four crescentic loops on the floor of the gastric pouches.

II. PEROMEDUSÆ. Scyphomedusæ with bell more or less conical in shape and with a usually well-developed horizontal constriction which divides it into two regions; an aboral, resembling quite remarkably the apical projection of the bell of certain Hydromedusæ; the marginal portion, which is eight or sixteen lobed and bearing tentacles and rhopalia or tentaculocysts. Stomach capacious with four gastric pouches which are separated by narrow septa, and extending into a circular sinus. Gonads much as in the former order.

III. CUBOMEDUSÆ. Scyphomedusæ with a distinctively quadrate umbrella, provided with a well-defined velarium, which is supported at the radial angles by thickenings or frenulæ. Marginal tentacles four, interradially disposed, and with four perradial rhopalia. Bases of tentacles often provided with wing-like expansions, pedalia.

IV. DISCOMEDUSÆ. Scyphomedusæ with shallow, or disk-shaped, eight lobed umbrella. Marginal sense organs eight, per- and interradially disposed about the margin. Tentacles often very numerous. Manubrium often very large, pendulous and complexly frilled or plaited. Stomach with four to eight or more gastric pouches, within which are borne the gonads.

The medusæ of this order are often of large size. Specimens of Cyanea reaching a diameter of from four to six feet in some cases and with tentacles having an extent of more than fifty feet when fully extended. The average size however, even of this species, is very much smaller, as will be noted later.

SYNOPSIS OF FAMILIES OF STAUROMEDUSÆ.

I. TESSERIDÆ. Margin of umbrella devoid of definite lobes or anchors; the umbrella attenuated at the apex into a hollow stalk, which in some genera serves as a means of attachment; eight tentacles, four of which are perradial and four interradial.

So far as known no representatives of this family come within our range.

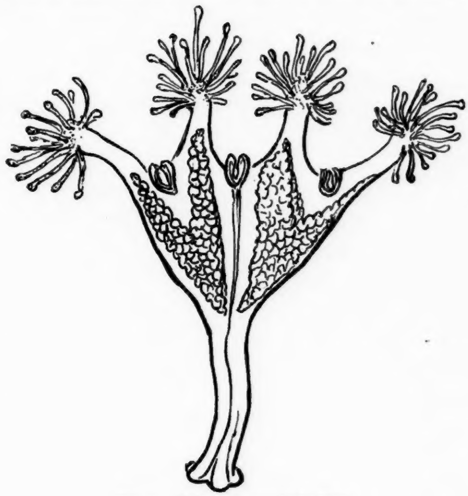

FIG. 1. *Halichystus auricula* Clark.

II. LUCERNARIDÆ. Margin of umbrella definitely lobed, each terminating in tufts of delicate knobbed tentacles; exumbrella attenuated at the apex as an organ of attachment; margin of umbrella with eight tentacles, arranged as in previous family, but sometimes modified as anchors.

KEY TO THE GENERA.

A. Without gastrogenital pockets in the sub-umbrella wall of the radial pouches.

1. Umbrella with 8 marginal anchors . . Haliclystus.
2. Umbrella without marginal anchors . . Lucernaria.

B. With four perradial gastrogenital pockets in the subumbrellar wall of the four radial pouches.

3. Margin of umbrella with 8 anchors . . Halicyathus.

Haliclystus auricula Clark. 1863.

Fig. 1.

Haliclystus auricula, Clark, 1863, 1878.
" " A. Ag. 1865.
" primula, Hæckel, 1877.
Lucennaria " " 1865.
Haliclystus auricula, " 1880.

Umbrella octangular-pyramidal, umbrella stalk quadrate-prismatic, approximately as long as the bell height. Eight arms, arranged in pairs; four perradial sinuses broader and deeper than the four interradials; each arm with from 100–120 tentacles; eight large marginal anchors.

Color.— Very variable, often including almost every tint of the spectrum, though generally having a single color.

Size.— Broad diameter 20–30 mm. Height, including stalk, 20–30 mm.

Distribution.— From Massachusetts Bay northward to Maine, etc.

Haliclystus salpinx Clark. 1863.

H. salpinx Clark, 1863.
H. salpinx A. Ag. 1865.
Lucernaria salpinx Hæckel, 1865.
Haliclystus salpinx Hæckel, 1880.

Umbrella octangular, stem quadrate, prismatic, with four interradial longitudinal muscles; eight arms, symmetrically disposed, each with a tuft of 60–70 slender tentacles. Marginal anchors very large about as long as the arms.

Distribution.— Chiefly Northeastern Atlantic coast.

Lucernaria quadricornis O. F. Müll. 1776.

Umbrella flat funnel-shaped or quadrate-pyramidal, approximately twice as broad as high. Stem cylindrical, single-chambered, about as long as the bell-height and with four interradial longitudinal muscles. Eight arms arranged in pairs, the four perradial sinuses of the bell margin as broad and deep as the four interradials. Each arm with from 100–120 tentacles.

Color.— Variable, gray, green, yellowish brown to red-brown.

Size.— Umbrella 50–60 mm., height including stalk, 50–70 mm.

Distribution.— As in Haliclystus.

Halicyathus lagena Hæckel. 1880.

Lucernaria auricula Fabr. 1780.
L. typica Greene 1858.
L. fabricii L. Ag. 1862
L. lagena Hæckel 1865.
Manania auricula Clark, 1863.
M. auricula A. Ag. 1865.
M. lagena Hæck. 1877.
Halicyathus lagena Hæck. 1880.

Bell deep flask-shaped, about twice as high as broad; stalk slender cylin-

drical, single chambered, much longer than height of bell. Arms eight, arranged in pairs, not longer than broad; each arm with 60–70 delicate tentacles. Eight marginal anchors.

Color. — Black or dark brown, occasionally reddish- or yellowish-brown.

Size. — 5–7 mm., height including stem, 20–30 mm.

Distribution. — Eastport, Me. (Stimpson), Swampscott, (Ag.), Greenland.

SYNOPSIS OF THE FAMILIES AND GENERA OF PEROMEDUSÆ.

Family PERIPHYLLIDÆ. Rhopalia 4, marginal lobes 16, tentacles 12.
Family Pericolpidæ. Rhopalia 4, marginal lobes 8, tentacles 8.

A single genus only of the Peromedusæ is represented within the range of the present synopsis, namely, Periphylla and under this three species have been recorded.

Generic characters: — Umbrella with four perradial, buccal pouches and with four basal funnels; gastric pouches with two rows of filaments.

Periphylla, hyacinthina Steenstrup. 1837.

Fig. 2.

Umbrella bell-shaped, about as broad as high; marginal lobes nearly right-angled truncated below; the eight tentacle lobes with about the same marginal dimensions as the rhopalial lobes; tentacles about double the length of the bell-height. Manubrium extending to the base of the marginal lobes, and about double as broad as high.

Color.—Exumbrella reddish, pedalia and marginal lobes red to violet, tentacles bluish. (Hæckel.)

Distribution. — Greenland, Steenstrup, Gulf Stream 90–100 miles S. E. off Martha's Vineyard (Fewkes).

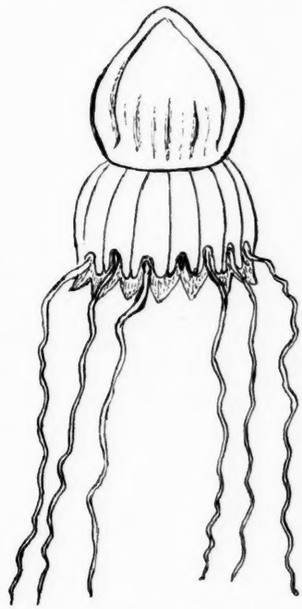

FIG. 2. *Periphylla peronii* Hæckel.

Periphylla humilis Fewkes. 1884.

Bell low conical, diameter twice that of height. Rhopalia 4, provided with protecting hood; marginal tentacles 12, of yellow color. Color of exumbrella brown, rough and opaque; central disk and corona rather uniform brownish in color.

Distribution.— Off Martha's Vineyard as for previous species.

Periphylla peronii Hæckel, 1880.

Charibdea periphylla, Per. & Les. 1809.
C. periphylla, L. Ag. 1862, Cont. Nat. Hist. U. S.
Stomolophus periphylla, Fewkes?

Umbrella low conical, about as broad as high. Marginal lappets 16, eight tentacular and eight ocular. Tentacles long and stout, about as broad at the base as the marginal lappets. Manubrium about as broad as high, somewhat cubical.

Distribution.— Tropical Atlantic, (L. Agassiz), St. George's Bank (S. I. Smith).

FAMILIES OF CUBOMEDUSÆ:

Of the Cubomedusæ only a single Family has been represented by species within the range of this synopsis, namely Charibdeidæ, and under this but a single genus and species.

Charybdea verrucosa Hargitt, 1902. Fig. 3.

Several specimens were taken at Woods Holl during the summer of 1902 and have been described by the present writer, *Am. Nat.* July, 1902. Bell ovoid in outline, as seen in profile, cuboid viewed from the aboral pole. Size from 2 to 3 mm. in short diameter by 4 to 5 mm. in the height. Surface dotted irregularly with light brownish, warty clusters of nematocysts. Rhopalia 4, preradially located, set in rather deep pockets, and shielded by projecting hoods. Tentacles short and spindle-like, with deep annulations, interradially situated. Velarium well-devel-

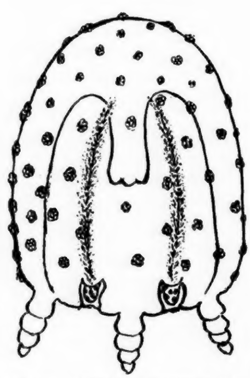

FIG. 3. *Charybdea verrucosa* Hargitt.

oped, but without distinguishable canals, supported by frenulæ on the inner perradial corners of the sub-umbrella. Gonads were undeveloped, and no distinguishable gastric filaments were present.

In color the specimens were light amber being darker on the tentacles.

As pointed out in the description before cited, the specimens under consideration show many points of difference or contrast as compared with typical Charybdea species. Mayer who has described a similar species from the Tortugas ascribes this to immaturity. This has seemed to me somewhat doubtful, and some hesitancy was entertained as to whether they probably come within the Charybdeidæ; but in the absence of specimens in sufficient numbers or undoubted maturity it seems impossible to more definitely settle the problem.

Mayer has described two species from the Tortugas, namely, *C. aurifera* and *C. punctata*. Both species were based on single specimens and both seemed immature. Hence the same doubt rests upon these as upon the previous species. A comparison of Mayer's figures, *Bull. Comp. Zool.*, XXXVII, No. 2, will show many points of similarity and suggests close relationships.

Synopsis of Sub-orders and Families of Discomedusæ.

Sub-order 1. Cannostomæ.

Discomedusæ with simple, quadrate mouth, devoid of oral lobes or tentacles; marginal tentacles short, solid.

Family Ephyridæ. Radial pouches usually 16, broad and simple; no marginal canal. Chiefly deep-sea forms, occasionally taken at the surface.

Family Linergidæ. Radial pouches broad, terminating in numerous branching, blind distal canals.

Sub-order 2. Semostomæ.

Discomedusæ with quadrate mouth, and with elongated, oral arms, or lobes, which are often complexly folded and frilled: marginal tentacles hollow, often very long. Marginal lobes usually 8.

Family Ulmaridæ. Radial canals of small size, but usually numerous and branching, the branches often anastomosing into an intricate network and finally uniting with a definite marginal canal.

Family CYANEIDÆ. Radial canals broad and pouch-like, and with numerous ramifying, blind, lobular canals; no circular canal; 8–16, rarely more, marginal lobes.

Family PELAGIDÆ. Radial canals rather broad but simple and without ramifying branches; no marginal canal; usually 16 marginal lobes.

Sub-order 3. RHIZOSTOMÆ.

Discomedusæ in which the mouth early becomes more or less overgrown and obliterated by the 8 root-like oral arms; gastric cavity extending into the oral arms and opening by funnel-like mouths on the edges and surfaces. Devoid of marginal tentacles.

Family TOREUMIDÆ. Radial canals 8–16, narrow and with anastomosing branches; devoid of marginal canal; rhopalia 8–16. Suctorial funnels on the outer (dorsal) surface of the oral arms.

Family PILEMIDÆ. Radial canals 8–16, occasionally more, variously branching and anastomosing; rhopalia 8. Suctorial funnels on both outer and inner surfaces (dorsal and ventral), of the oral arms.

KEY TO THE GENERA.

EPHYRIDÆ.

1. Gonads four, simple, horse-shoe-shaped; devoid of marginal lobes or lobular pouches . . . . Ephyra
2. Gonads 4, Lobular pouches 16; 8 ocular, 8 tentacular, Bathyluca.
3. Gonads 8, symmetrically disposed; 16 lobular pouches, ocular, Nausithoë.
4. Gonads 8, symmetrically disposed; 32 lobular pouches, 16 ocular, 16 tentacular, ... Nauphanta.
5. Gonads 8, arranged in pairs; lobular pouches 64–128, number indefinite, ... Atolla.
6. Gonads 4, two-lobed, with interradial septum . . . . . Linerges.

ULMARIDÆ.

7. Rhopalia 8; tentacles numerous, short, borne on under margin of the umbrella without the velar lappets; oral arms 4, simple but with the margins fringed with nematocysts, ... Aurelia.
8. Rhopalia 16; tentacles numerous, long, in 16 clusters on the lower margin within the velar lappets . . . . Phacellophora.

CYANEIDÆ.

9. Rhopalia 8; tentacles very numerous, long, arranged in 8 clusters, each comprising several rows. Oral lobes four, but highly folded and fringed, ... Cyanea.

Pelagidæ.

10. Marginal tentacles 8; marginal lobes 16, ... Pelagia.
11. Marginal tentacles 24; marginal lobes 32, ... Chrysaora.
12. Marginal tentacles 40; immature specimens, often less in younger individuals; marginal lobes 48, ... Dactylometra.

Ephyroides rotaformis Fewkes. 1884.

Report U. S. Fish Commission, p. 949.

Among medusæ of the Gulf Stream Fewkes has described what is considered by him a new genus and species of an Ephyra-like medusa.

The generic characters given are somewhat indefinite, no mention being made as to gonads, radial pouches, sense organs, etc. The following brief notes are condensed from the above cited report:

Umbrella flat discoid, and viewed from the aboral pole comprises three zones:—"Discus centralis; Zona coronalis; Zona marginalis." The last named zone is marked by definite marginal lappets of large size with rounded outlines twice as long as broad, and 16 in number. Interposed between the lappets are a similar number of gelatinous elevations, "socles," ending a short distance from the deepest point of the marginal incision and abutting the line of junction of the discus centralis and zona coronalis. The marginal lappets are supported at their base by a pair of gelatinous "socles."

Distribution.—

Nausithoë punctata Koll.

Bull. Mus. Comp. Zoöl. Vol. XXXVII, p. 67.

Umbrella flat, 9–10 mm. broad. Marginal tentacles 8, stiff, about 7 mm. long. Rhopalia 8, alternating with the tentacles. Marginal lappets 16, long and flexible; gastric pouches 16, simple, and extending to the lappets. Mouth simple, quadrate, devoid of lobes or tentacles.

Distribution.— Bahama and Tortugas Islands. (Mayer.)

Nauphantopsis diomedeæ Fewkes. 1884.

Op. cit. p. 946.

From a fragmentary specimen collected by the Albatross in the Gulf Stream Fewkes has proposed the new genus and species here mentioned. The following very brief synopsis of characters are condensed from his description. Report U. S. Fish Commission 1884.

Umbrella high disk-shaped, with marginal walls probably somewhat vertical. Marginal lobes 32. Tentacles 24, rhopalia probably 8.

Distribution.— Lat. 38° N., long. 69° W.; depth 2.033 fathoms.

Atolla bairdii Fewkes. 1884.

Report U. S. Fish Commission, p. 936.

Umbrella disk-like with aboral center convex. Marginal lappets 44. Marginal tentacles 22, each supported by a gelatinous "socle." Rhopalia 22, situated in notches between the lappets. Manubrium large, with simple mouth. Gastric pouches 22.

Color.— Slightly bluish, with rust-colored patches, especially on the border of the coronal furrow.

Distribution.— Gulf Stream, between N. lat. 35–38; W. long. 72–75. One specimen from the depth of 991 fathoms, the other from surface.

Atolla verrilii, Fewkes. 1884.

Op. cit. p. 939.

Umbrella flat discoid, six to eight times broader than high.

Marginal tentacles 22 to 28, with same number of interposed rhopalia.

Marginal lappets same number as the combined number of tentacles and rhopalia.

Distribution.— Between lat. 38–40; long. 68–71; from depth of from 373 to 2,369 fathoms.

Linerges mercurius Hæckel. 1880. Fig. 4.

Op. cit. p. 950.

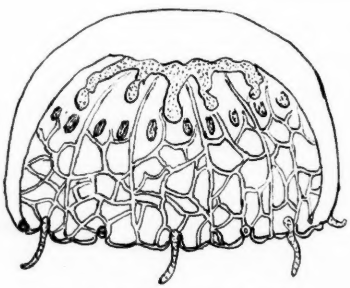

FIG 4. *Linerges mercurius* Hæckel.

Umbrella mitre-shaped, with arched crown and usually vertical sides, diameter about twice that of height. Lobular canals bowed and rounded out. Tentacles cylindrical. Gonads horseshoe-shaped. Size 12 to 16 mm. broad. 6 to 10 mm. high.

Distribution.— Bahama and Tortugas Islands (Mayer). Gulf of Mexico. Straits of Florida (Fewkes).

Bathyluca solaris Mayer. 1900.

Bull. Mus. Comp. Zool., XXXVII, p. 2.

Umbrella flat and rather thick, aboral surface dotted with batteries of nematocysts. Marginal lappets 24; tentacles 16, long and hollow. Rho-

palia 8. Manubrium cruciform, simple, devoid of arms or appendages. Gonads 4, horseshoe-shaped, beneath which on the subumbral wall are four open sub-genital pits. Stomach large and with 16 gastric pouches, eight of which extend to the ocular lobes and eight to the tentacular lobes.

Color. Disk translucent, slightly bluish; clusters of nematocysts dull yellowish-brown; tentacles slightly greenish.

Aurelia flavidula Per. & Les. Fig. 5.

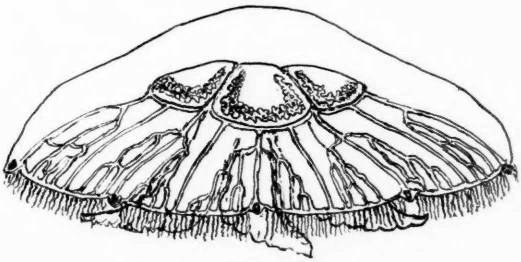

FIG. 5. *Aurelia flavidula* Per. & Les.

Umbrella flat and disk-like, somewhat arched above; margin normally eight-lobed and with eight rhopalia located in the marginal sinuses. Many variations from the normal octamerous form are found in some collections reaching as high as 25%.

Marginal tentacles numerous, short, forming a delicate fringe about the entire margin except at the rhopalial sinuses. Radial canals 16, of three sorts, per- inter- and adradial; the first two series branching and anastomosing freely, the last usually straight and simple from its origin to its junction with the marginal canal.

Manubrium cruciform in cross section, and with four long oral arms which are more or less fimbriated and the margins bearing numerous batteries of nematocysts. Gonads crescentic in form, borne upon the floor of the four gastric pouches.

Color.—Aurelia is among the duller colored of the Scyphozoa, the bell being quite transparent, but with a bluish opalescence. The gonads present a pale pinkish hue, though the ova are almost clear white as examined singly.

Distribution.—Aurelia is one of the commonest of the Atlantic coast medusæ and ranges from the coast of Maine to Florida. It is most abundant during the early summer or spring along most of the New England coast, though fairly abundant northward till late in summer. Its breeding habits seem to be somewhat continuous during most of the summer. The scyphistoma stage is a somewhat extended one, probably lasting over the entire winter season. Kept for weeks in aquaria they showed no signs of metamorphism. I have taken them in all stages of strobilization during

April and early May, when ephyræ were being discharged in great numbers. During the summer season the polyps bud and stolonize very freely, from a single scyphistoma a colony of many individuals arising within a space of ten days. Figure shows such a colony reared within a watch-glass aquarium.

Aurelia marginata L. Ag. 1862.

Cont. Nat. Hist. U. States, Vol. IV.

Umbrella flat dome-shaped to hemispherical, three times as broad as high. Mouth-arms relatively small, considerably shorter than the umbrella radius. Gonads very large.

A southern medusa, reported by Agassiz from Key West, Florida.

Callinema ornata, Verrill. 1869.

Umbrella flat and disk-shaped, rather thick and aborally rounded; the exumbrella surface covered with wart-like papillæ; walls transparent and with prominent radial canals which are of two sorts, one branching and anastomosing, the other simple and straight, each 16 in number. Margin with 16 lobes deeply incised within which is located a conspicuous rhopalium. Tentacles numerous and of varied size and length, arising from the under surface of the margin beneath the marginal canal. Manubrium large and pendulous and with prominent folded oral lobes, somewhat like those of Cyanea. Gonads 8, in prominent pouches within the gastric cavity. In size specimens vary from 10–18 inches in diameter. Distribution, taken at Eastport, Maine, by Verrill, and later by Fewkes, from whose account this description is condensed. *Cf. Bull. Mus. Comp. Zoöl.* Vol. XIII, No. 7.

Cyanea arctica, Per. & Les.

Umbrella flat and disk-like, with a central aboral convexity, with 8 principal lobes and 16 or more secondary lappets; ocular pouches small subtriangular, tentacular pouches two or three times as broad as the ocular.

Color. — Radial pouches purplish to brownish; oral lobes deep chocolate brown; gonads yellowish white; tentacles variably colored, yellowish, orange, purplish or brown.

Size. — From 100 to 500 mm. in diameter, though in many cases larger. A. Agassiz notes one having a size of seven feet and with tentacles more than 100 feet in length.

Distribution. — Almost the entire Northeast coast of the United States.

L. Agassiz has described two additional species, namely, *C. fulva*, and *C. versicolor*. These are of doubtful distinctness, variation in size and coloration being the chief differences clearly recognizable. Collections

made from a wide range of New England coast waters show every feature of intergradation between the several extremes and sufficiently establish the fact that at most only *C. versicolor*, of the Carolina coast, has possibly a varietal distinctness.

In this connection it is pertinent to refer to the morphological variation in the common species. *C. arctica*, which is nearly as marked as in Aurelia, including variation in the radial symmetry, number of gonads, oral arms, etc. Variation in color is sufficiently indicated in the references just given.

Pelagia cyanella Per. & Les. Fig. 6.

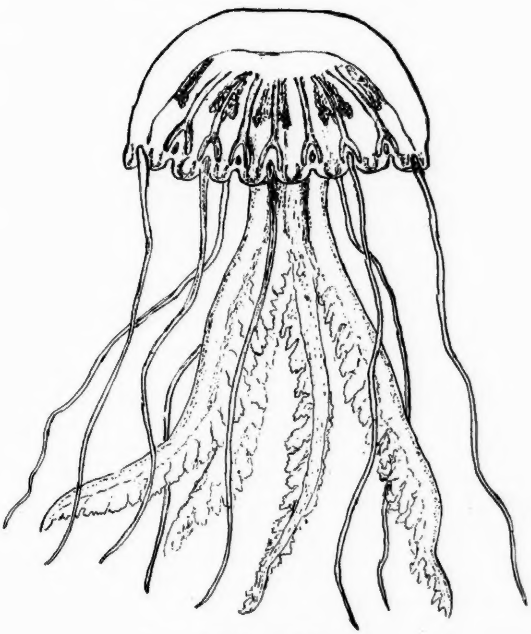

FIG. 6. *Pelagia cyanella* Per. & Les.

Umbrella disk-like, with rather highly arched aboral surface; marginal lobes 16, and with 8 rhopalia and 8 tentacles symmetrically and alternately disposed at the lobular sinuses. Gonads 8, forming conspicuous pouch-like masses within the gastric pouches of the tentacular radii. Manubrium large and pendulous, with four frilled oral arms approximately as long as the tentacles.

Color.— Disk translucent bluish tint, sprinkled with reddish-brown pigment spots over the entire exumbrellar surface, the more numerous near

the margin and forming crescents at the marginal lobes; manubrium similarly mottled on the outer edges of the arms, inner edges and frills delicate flesh-colored; tentacles a dull, madder-red; gonads pale purplish.

Two specimens of this medusa have been taken in the Woods Holl region recently, the last in July, 1902, some 65 miles south of Marthas Vineyard. According to Agassiz, Contr. Nat. Hist. U. S., the development of this medusa is direct, skipping the fixed polyp and strobila stages.

Dactylometra quinquicirri L. Ag.

Umbrella rather high and arched aborally much as in Pelagia, disk three to four times as broad as high. Manubrium long and pendulous with slender oral arms, which are more or less frilled as in *P. cyanell.* Rhopalia 8, marginal tentacles 40, marginal lobes 48. In arrangement five tentacles are located between each pair of rhopalia in adult specimens, though in some cases only three are present, particularly in small specimens. Gonads in four masses within the gastric pouches, and beneath each gonad in the subumbral wall is a prominent subgenital pit.

Color.— In general much like Pelagia, though less brilliant, the various hues being paler and somewhat more delicate. Exumbrella delicate bluish, mottled with reddish brown fading into yellowish; tentacles reddish to orange; oral arms pale pinkish with bluish tint variously blended, making this medusa one of the most beautiful among the Pelagidæ.

Distribution.— Is less extended than that of Aurelia or Cyanea. It is quite common in Buzzard's Bay, Vineyard Sound, Nantucket.

Like several of the preceding Dactylometra exhibits considerable variation. According to Mayer, *Bull. Mus. Comp. Zool.* Vol. XXXII, No. 7, the tertiary tentacles arise on either side of the ocular lappets. In several specimens examined during the past summer this was not found to be the case. On the contrary they sprang in every case examined between the primary and secondary sets. Again according to the same observer the tertiary tentacles only appear when the medusæ approximate maturity, and after attaining a size of 130 mm. in diameter. On the contrary I found them well developed in specimens having a size of only 40 mm. and where no gonads were developed. There was also noted the same variation in the marginal lobes and other organs which have been noted in connection with species previously noted.

Dactylometra lactea L. Ag. 1862.

This is a southern medusa, no record of its occurrence north of Florida having come to my notice. In general aspects it is much like the preceding species, though of smaller size. Its color is milk-white with a purplish iridescence, and with yellowish dots over the exumbrella. It has been reported from the Bahama and Tortugas Islands, from the Gulf of Mexico, and from the coast of South America.

Cassiopea frondosa Lamarck. 1817.
Polyclonia frondosa L. Ag. *Cont. Nat. Hist. U. S.* 1862.

Umbrella disk-like, arched, about three times as broad as high, with 12 distinct, broad, ocular radial stripes. Margin with 12 broad velar lobes. Manubrium approximately as long as the bell-radius, very stout, pinnæ of mouth arms variously parted and distally plumose or frondose.

Color.— Bluish to olive-green ; arms greenish or yellowish, with whitish terminal filaments.

Distribution.— Coast of Florida, Tortugas Islands, etc.

Stomolophus meleagris L. Ag. 1862.
Contr. Nat. Hist. U. S.

Umbrella high, arched, more than hemispherical, with 8 deep ocular incisions, and with 96 marginal lappets.

Color.— Whitish-blue, the margins becoming yellowish-brown, margin lappets dark brown.

Size.— About five inches broad by about three inches high.

Distribution.— Southern Atlantic coast, Savannah, Charleston, etc.

Syracuse University,
The Zoölogical Laboratory,
Feb. 10, 1903.

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SYRACUSE UNIVERSITY,
The Zoölogical Laboratory,
Feb. 10, 1903.

NOTES AND LITERATURE

GENERAL BIOLOGY.

Development and Evolution.[1] — In this work, which is a collection of short papers originally published in various magazines, the author attempts to apply the biogenetic as contrasted with the psychogenetic method to the facts of ontogeny and phylogeny with the purpose of determining "which sort of a theory of biological evolution" is most satisfactory. As a psychologist Professor Baldwin tends to emphasize the importance of the psychic in evolution and development; his theory is consequently psychophysical, not vitalistic.

Of the three parts of the book the first deals with problems of genesis, the second with the method of evolution, and the third with certain psychological facts and philosophical problems.

"It has been the psycho-physical, not the physical alone, which has been the unit of selection in the main trend of evolution" says the author. In support of this statement he presents facts of social transmission, and individual intelligent accommodation to conditions. Upon the plasticity of the organism, its imitativeness, and its ability to make intelligent adjustments Professor Baldwin lays great stress. In fact it sometimes seems as if he might explain everything by simple imitation.

The whole work, in so far as it can be unified for purposes of brief description, is a statement of the author's theory of "Orthoplasy" in connection with a marshaling of the evidences of organic selection. In contrast with natural selection, which is usually thought of as due to the destruction of the unfit, organic selection is essentially due to the fact that individual accommodations keep certain individuals alive, and thus permit of that accumulation of variations which determines the direction of evolution in later generations. If such a process as that of organic selection is occurring it is obvious that the assumption of the inheritance of acquired characters, in the usual sense, is unnecessary. That use-inheritance is not a factor in

[1] Baldwin, James Mark. *Development and Evolution.* Including Psychophysical Evolution, Evolution by Orthoplasy, and the Theory of Genetic Modes. New York. Macmillan, 1902. 8 vo. xvi + 395 pp.

the evolution process almost every paragraph of "Development and Evolution" serves to show.

Intelligence is represented as the highest form of the process of "accommodation," for with it comes adaptiveness, educability, and the ability to profit by social tradition.

The book, although bad in form, contains much valuable material. One can but feel that the author might well have taken the trouble to carefully rewrite it in a systematic and logical fashion instead of merely throwing together a lot of fragmentary discussions, without any attempt at the avoidance of repetition. Professor Baldwin evidently likes to make his readers work. R. M. Y.

Biological Laboratory Methods.[1] — According to the author's introduction, *Biological Laboratory Methods* is a book intended to meet a demand "for suitable text-books which will give full and clear instructions concerning the use of the microscope and the other instruments and methods required in these [biological] laboratories." Furthermore, Dr. Mell says, such a book "should begin at the beginning and treat of all matter relating to the subject in simple language. . . ." An examination of Dr. Mell's book reveals an unfortunate discrepancy between aim and achievement. The book begins anywhere but at the beginning, while fullness, clearness and simplicity of language are qualities which are not everywhere evident. In a book of 321 pages intended for "the beginner" in biological work, 44 pages are given to the microscope and 66 pages are devoted to chapters on "Preparation of the Tissue for Mounting," "Imbedding Methods," "Stains, Their Preparation and Use," and "Mounting the Tissue for Preservation," while 84 pages are given to photography and bacteriological methods. A description of Born's reconstruction method and "Methods for the Preservation of Marine Organisms" occur under the heading "Maceration." Essential details, particularly in the description of the microscope, are lacking, while the non-essential is everywhere present to the inevitable confusion of an inexperienced student. Under "Imbedding Methods," directions for imbedding in paraffin having been given (with the warning that "Prolonged heating at any time is injurious to many forms of vegetation"), the student is told that the mass should be "shaped into a rectangular form, so that when placed in the microtome one face of the mass will be square with the knife and the

[1] Mell, P. H. *Biological Laboratory Methods.* New York. Macmillan, 1902. 8vo. xii + 321 pp., 127 figures.

opposite edge parallel with it." With these directions as an example of clearness, the accounts of numerical aperture and polarized light may best be imagined. Students will find the "too voluminous" "works of reference" of Carpenter, Gage and Lee not rendered less useful by the appearance of "Biological Laboratory Methods."

H. W. R.

ZOÖLOGY.

Sexual Dimorphism.— Sexual dimorphism among animals and the evolution of secondary sexual characters form the subject matter of an interesting volume by Cunningham.[1] The author points out the inadequacy of natural selection as an explanation of the very constant characters upon which animal classification is based in that it must be admitted that many of these characters are of no obvious advantage to their possessors. He next turns his attention to secondary sexual characters and claims that here too that special form of selection called by Darwin sexual selection is ineffective because again the differences are not of a kind to afford a basis for the selective process. In his opinion the origin of these characters has been due to Lamarckian factors. It must be admitted that the influence of the environment profoundly changes animals. Those changes that occur at the breeding season are dependent upon the changes of habits characteristic of that period. They consequently form the basis for the evolution of secondary sexual characters. That these changes may be inherited is well known, hence we should not deny that they are examples of the inheritance of acquired characters because we are ignorant of the method by which their inheritance is accomplished. From this standpoint the author reviews a large range of secondary sexual characters from the mammals to the lowest metazoa in which such characters are known. While the line of argument will probably not be convincing to even the milder Weismannians, the wide range of illustrations brought together by the author will afford interesting reading to every zoölogist.

[1] Cunningham, J. T. *Sexual Dimorphism in the Animal Kingdom.* London. Black, 1900. 8vo, xii + 317 pp., figs.

Parasites and Geographical Distribution. — The value of parasites of different animals for the investigation of the geographical distribution of the latter has been pointed out recently by H. von Ihering.[1] The object of modern zoogeographical research is chiefly to trace the origin of the different forms of life, and, with respect to the fauna of a limited section of the earth's surface, it is important to settle the question whether the inhabitants originated there, or whether they immigrated from other parts, and, in the latter case, whence they came.

Von Ihering studies the present South American fauna from this point of view, and points out that, among the fauna of this continent, we can distinguish two chief elements: the one is peculiar to it, that is to say, was present there before the second half of the Tertiary, while the other immigrated from the North, after the Miocene. Then he proceeds to demonstrate that the parasitic worms found in these two groups of animals exhibit peculiar differences, so that it is possible, under certain circumstances, to draw the opposite conclusion that the parasites of a certain species of animal indicate, whether the latter belongs originally to South America, or whether it immigrated in the later Tertiary.

The instances quoted are taken chiefly from among Mammals and Birds, but it is evident that also other groups may furnish examples.

In conclusion, von Ihering condenses his results in three fundamental "biological laws," which we reproduce here, freely translated:

(1) Land animals, even if they migrate over a large extent of territory do not lose the parasitic worms peculiar to them because the lower animals which serve as intermediate hosts offer everywhere analogous conditions, provided everything else remains unchanged. Although, in new areas of distribution, some new parasites may be added, the old conditions largely remain unchanged, which is very evident in South America, where the parasitic worms of the holarctic region are not found with the indigenous (autochthon) mammals or birds, but only with the strangers (heterochthon) that immigrated at a late period.

(2) Under these circumstances, helminthology becomes a valuable aid for the analytic method of zoogeography, and we may confidently obtain by it important results as to the history of such groups in which we do not possess satisfactory geological material, or in which such material naturally cannot be expected.

[1] Ihering, H. von. Die Helminthen als Hilfsmittel der zoogeographischen Forschung, *Zoolog. Anzeig.* Bd. 26, 1902, pp. 42–51.

(3) Helminthology treated in this way, may also aid paleontological research, since the relations between parasites and hosts, and their migrations and geological age, permit conclusions to be drawn as to the age of the single larger groups (of the parasites) and even of their genera and species. A. E. O.

Two papers on the Nautilus.[1] — These two works which appeared nearly simultaneously form the most important contributions to our knowledge of the tetrabranch cephalopods which have appeared for years. Dr. Griffin had for his material numerous specimens collected by the Menage expedition of the Minnesota Academy of Sciences, while Dr. Willey collected his among the islands of the Eastern Archipelago where he went in the hopes of obtaining the embryology of this most interesting animal.

Neither of the papers — which extend over 95 and 91 pages and are illustrated by several text figures and 17 and 9 plates respectively — can be summarized here. The two, to a great extent, supplement each other. Dr. Griffin has endeavored to give a connected account of the anatomy, utilizing not only his own dissections but the accounts of his predecessors and hence gives a wealth of detail. Willey on the other hand describes rather what he himself has investigated and his comparisons are those of the broader morphological treatment. A single example will illustrate the different points of view. In treating of the digital tentacles Willey gives comparatively little about the anatomical structure but tries to work out a numerical nomenclature of these parts, in which he comes to results widely at variance with the previous studies of Vayssière. Griffin, on the other hand describes the anatomy in great detail, but says nothing regarding the arrangement, although he knows of Vayssière's work. He gives however a plan of their position which differs in some respect from that of Willey. Willey further enters with the question whether these tentacles are to be compared to the arms of the dibranch cephalopods or to the acetabula as has been suggested, inclining to the former view.

The sections relating to the foot in Dr. Willey's paper are of interest. Accepting Grenacher division of the molluscan foot into a median protopodium and lateral epipodia and discussing change of function and its relations to change of organs and to topography he argues for the conclusion that the siphon represents the protopodium

[1] Griffin, L. E. The Anatomy of Nautilus pompilius, *Memoirs National Acad. Science*, viii, 1900 (1902). — Willey's Contribution to the Natural History of the Pearly Nautilus, in his *Zoölogical Researches*, part vi, August, 1902.

of the gasteropod and the tentacles the epipodia. He also claims that the post-anal papillæ are osphradial in nature and are therefore an additional evidence for metamerism in these forms, while on the other hand he fails to find any metamerism in the cœlom.

Besides dealing with Nautilus Willey presents numerous other facts in this number of his "Results" among them many details as to the anthropology of the regions visited, and notes on tunicata, Amphioxus and Enteropneusta. K.

BOTANY.

Recent Literature on Seedlings.— In *Torreya* (Vol. II, pp. 113–117, August, 1902) Lloyd discusses "Vivipary in Podocarpus." During the last winter a specimen of *Podocarpus makayi* bore an excellent crop of fruit which germinated almost without exception and on the parent plant. The hypocotyl, he finds, is, when developed, of that club shape characteristic of certain other viviparous plants, as the mangroves, and is rich in food material, especially starch, which seems to be derived not only from the endosperm, but from its own photosynthetic activity as well as may be inferred from its greater weight, green color, and the presence of stomata. In most cases the primary root does not develop, but its place is taken by one or usually two lateral roots formed near the end of the hypocotl. He calls attention to vivipary in *Melocanna bambusoides* and its possible existence in other grasses, in *Tillandsia albisiana* and in *Quercus fusiformis* as well as interesting similarities in other oaks, and concludes that vivipary is by no means the unusual condition it is supposed to be. F. W. Rane ("How to grow a Forest from Seed." *Bull. N. H. Ag. Exp. Sta.* 95, November, 1902), figures a few tree seedlings though the bulk of the paper is naturally of an economic nature. In *Proc. Cambridge Philosophical Soc.*, Vol. XI, pp. 445–457, Pl. 5, 1902, Gardiner and Hill consider the histology of the Endosperm during the germination of *Tamus communis* and *Galium Tricorne*. Chauveaud in *Bull. Mus. d Hist. Nat.*, 1902, No. 1, pp. 52–59, discusses the arrangement of the vascular system in the cotyledon of the onion, *Allium cepa*.

Cyril Crossland ("Note on the Dispersal of Mangrove Seedlings," *Ann. of Bot.*, Vol. XVII, pp. 267–270, fig. January, 1903) observed mangroves growing in large numbers in the crevices in the hard coral limestone surface near high water mark on the east coast of Zanzibar, but only occasionally found them growing in mud, where the well-known method of planting may be observed. He frequently found embryos planted in holes in the rock at a distance of a hundred yards, and in a few cases some miles from the nearest parent tree. He frequently found the embryos floating vertically in the sea with the leaf bud just projecting above the water and concludes that the embryo is planted in any softness or crevice of the bottom upon the falling of the tide. The observation adds a quite distinct method of distribution for this interesting plant.

A contribution of importance to our knowledge of seedlings is that of Willis in his paper on the "Morphology and Ecology of the Podostemaceæ."[1] In an earlier number of the same publication Mr. Willis treated the systematic relations of the forms found in India and Ceylon and in the present paper for which the other was preparatory he discusses the anatomy and ecology of the different forms and when material was available the developmental stages as well. The peculiar ecological conditions under which the members of the family are to be found are discussed, and in addition to the descriptions and figures of the young stages of several forms given in the systematically arranged portion of the paper some theoretical considerations are taken up in his quite extensive general discussion and summary.

The germination of the seed of *Peperomia* and *Heckeria* has been studied by Johnson (*Bot. Gaz.*, Vol. XXXIV, pp. 321–340, Pls. IX and X. 1902). He finds that the swelling of the embryo and endosperm bursts the seed coats and that the endosperm protrudes through the rent as a sack, which surrounds the small, undifferentiated embryo until cotylelons and root have been developed when the root breaks through the endosperm which still surrounds the tips of the cotyledons and remains imbedded in the seed till all the starch of the perisperm is absorbed. While only careful chemical work can yield a definite answer to the question the morphological features indicate that the aleurone containing endosperm of these forms serves not as a storage organ for food material, but as a digesting and absorbing

[1]Willis, J. C. Studies in the Morphology and Ecology of the Podostemaceæ of Ceylon and India. *Ann. Roy. Bot. Gard. Peradeniya.* Vol. i, pp. 267–465, Pls. IV–XXXVII. 1902.

apparatus for transferring the reserve starch of the perisperm to the embryo. He suggests that in several genera of Cannaceæ, Polygonaceæ, Phytolaccaoceæ, Caryophyllaceæ, and others, a thin layer of endosperm separating perisperm and embryo may serve the same function. J. A. HARRIS.

The Origin of Monocotyledons.— The importance of a study of the seedling stages of plants in classification is being much emphasized of late. In a recent number of this Journal, Professor Campbell (*Am. Nat.*, Vol. XXXVI, pp. 7–12, January, 1902) touches on this question. In a more recent number (*Am. Nat.*, Vol. XXXVI, pp. 981–982, December, 1902) was reviewed the preliminary paper of Miss Sargent in which she announced a theory of the origin of the Monocotyledons from a dicotyledonous type. In the following number of the *New Phylologist*, (Vol. I, pp. 131–133, June, 1902) Tansley commends very highly in some ways the paper by Miss Sargent, but calls attention to the freedom with which the hypothesis of the derivation of a simple structure from a more complex one is nowadays used in morphological work, and to the danger of the too free use of this hypothesis in biological speculations, unless the special conditions determining the reduction are to be ascertained, since there seems to be no reason for believing that there is any general cause leading to reduction as compared with the primary tendency to increase in bulk and complexity of structure. He thinks that, while of the greatest interest in many ways, the generalized conclusions of Miss Sargent's paper should not be accepted without careful consideration.

In the current number of the *Annals of Botany*, Miss Sargent [1] presents in greater detail the theory recently announced, though she states that the evidence she has accumulated will not be published in detail until her monograph on the comparative anatomy of seedlings of the Liliaceae is completed. In the opening pages she discusses the nature of the evidence employed in formulating her theory, This is followed by observations on the anatomy of seedlings, occupying nearly sixty pages, and considering the tribes Scilleæ, Tulipeæ, Asphodeleæ. Allieæ, Dracæneæ, Asparageæ and Aloineæ of the Liliaceæ, to which her work has been principally confined, with fewer examples from the Amaryllidaceæ, Iridaceæ,

[1] Sargent, E. A Theory of the Origin of the Monocotyledons, founded on the Structure of their Seedlings, *Ann. of Bot.*, Vol. xvii, pp. 1–92, Pl. I–VII, January, 1903.

Aroideæ, Palmeæ and Scitamineæ, of the monocotyledons and the Ranunculaceæ of the dicotyledons. In the third part she takes up general considerations on the origin of the monocotyledons.

In the space of a review, it is necessarily impossible to state in detail the evidence presented, but some of the main points of argument may be given. As in her previous paper she affirms her belief in the real systematic value of some of the vascular characters of the young seedling — at least of the Liliaceæ — and emphasizes the structural similarity of some of the Ranunculaceous seedlings to those of certain forms which she concludes represent the primative type of vascular arrangement in the Liliaceæ. She expresses her belief in the genetic connection of Eranthis and Anemarrhena, but even if there be no historical connection, she maintains that the structure of Eranthis may illustrate the double origin of the Anemarrhena cotyledon. Two tables are given, one listing dicotylodenous seedlings with a well-marked cotyledonary tube and the others those in which the union of the cotyledons occurs along one margin only. The ecological relations of these seedlings are discussed in relation to their bearing upon the development of a permanent monocotyledonous type, and it is found that almost all belong to plants of geophilous habit and that in some cases the whole structure remains under ground during the first year of their growth, developing underground organs for the tiding over of the unfavorable vegetative period to follow. Such considerations have led her to regard the monocotyledon as an organism adapted primarily to a geophilous habit, and she thinks that when considered from this point of view many puzzling details of structure in the monocotyledons become comprehensible. A brief discussion of some of these points is given. A bibliography of forty-five titles lists the literature to which reference is made.

While the presentation of the theory is confident, it is not without due reserve. "The evidence is obviously incomplete. The theory itself cannot be considered as proved in any sense. It is brought forward as a working hypothesis which I have found in practice to be suggestive and illuminating." The favorable tone of the present review may be attributed to the desire of the reviewer to present the theory from the point of view of the one who proposes it, but no one will deny that the data presented in the paper is of the greatest value and that the theoretical considerations will receive the careful attention of botanists and be of importance in the elucidation of the great problem, to the solution of which the paper is an important contribution.

A recent paper by Mr. Lyon,[1] whose work on the embryogeny of Nelumbium has been a stimulus to work of this nature, has apparently not come to the notice of Miss Sargent. This paper considers primarily not the origin of the monocotyledons and dicotyledons but the origin of the cotyledon itself. His conclusions are of such interest, and part of them so directly connected with the questions with which Miss Sargent's paper is concerned that it seems well to state them briefly. Of the three elements, cotyledon, stem and root of the typical embryo of the pteridophytes and angiosperms, the cotyledons do not represent modified leaves, but are primarily haustorial organs, originating phylogenetically as the nursing foot in the Bryophytes and persisting in the higher plants. Thus the monocotyledonous condition occurring in the bryophytes, pteredophytes, and Monocotyledons is to be regarded as the primitive one while the two or sometimes more cotyledons of the dicotyledons are the homologues of the single cotyledon of the monocotyledons.

J. A. HARRIS.

French Forestry.[2] — Despite the different conditions under which French and American foresters have to work, Professor Mouillefert's *Traité de Sylviculture*, the first part of which has just appeared, is well calculated to be of much service even in this country. The remaining three volumes of the series are in press and are promised for the current year.

The bulk of the present volume is devoted to detailed accounts of the principal species both native and foreign with which French forestry is concerned. Each is described and illustrated by remarkably good figures showing commonly the winter habit, twigs with buds, the leaves, inflorescence, flowers, fruit, seeds, germination and wood. Reference is made to the geographical distribution, the tree's preference as regards soil and climate, and the best methods of propagating and tending. Considerable attention is given to the wood, especially as regards distinctive structural features and economic uses. The uses of other parts is also given, as well as an account of the general economic importance of the tree, exhibited so far as possible by statistics. Finally, its more important insect enemies and vegetable parasites are mentioned and the nature and extent of the injuries they inflict briefly indicated.

[1] Lyon, H. E. The Phylogeny of the Cotyledon, *Postelsia*, Vol. i, pp. 57–86, 1902.

[2] Mouillefert, P. *Principales Essence Forestières préceedées de notions de statisque forestières*. Paris, Felix Alcan. 1903. 12mo, xii + 545 pp., 630 figs.

Near the end of the book is a synoptical table or key to the principal woods distinguished by features visible to the naked eye or under a magnification of about 20 diameters.

A preliminary part of about 40 pages states clearly and concisely important conclusions drawn from French forestry statistics; modern views of the influence of forests on water supply and climate, and the influences of climate, soil, forest covering, commercial and economic considerations, etc., on forest production. The volume closes with a full index, thus making this part of the treatise complete in itself.

F. L. S.

Kraemer's Course in Botany and Pharmacognosy [1] presents in convenient form a good general account of the minute and the gross anatomy of vegetable drugs and their microchemistry. Following the general morphological part are chapters devoted to the description and discrimination of drugs in the crude state and in powder. In this part excellent keys are included by means of which the student is helped to recognize any official drug. A third part deals briefly with the most useful reagents required in pharmacognosy, and with simple methods of making microscopic preparations. There are 17 plates containing 128 figures, 6 of which are colored. All are clearly drawn and well printed on clayed paper. Besides a full general index there is a special index to powdered drugs.

The book is remarkably well calculated to give students of pharmacy all the botany they need in preparing for their profession. The style is unusually clear and direct, and an orderly comprehension of the more difficult topics is much facilitated by the use of tables. In preparing this work Professor Kraemer has done a good service to many students and teachers.

F. L. S.

Notes. — *The Journal of the New York Botanical Garden*, for February, contains information concerning the research scholarship recently established at that Institution; an interesting account by Mrs. Vail of Jonas Bronck and his Bouwery in New Amsterdam, and some chemical studies of *Sarracenia purpurea*, by Gies.

"Why Popcorn pops" is the subject of an article by Wilbert in the *American Journal of Pharmacy* for February.

[1] Kraemer, Henry. *A Course in Botany and Pharmacognosy*. Philadelphia, 1902. 12mo. 384 pp., 128 figs.

Professor Spalding's presidential address before the Society for Plant Morphology and Physiology, dealing with the rise and progress of ecology, is published in *Science* of February 6th.

An address before the Western Railway Club on Timber Preservation, well illustrated with figures of botanical interest, has been described by Dr. von Schrenk.

An account of silkworm food plants, well illustrated, has been published by Oliver as *Bulletin 34 of the Bureau of Plant Industry of the Department of Agriculture.*

An illustrated account of plants injurious to sheep, based on a Bulletin of the Nevada Experiment Station, is contained in *The Pacific Rural Press* of February 7th.

An article on electromotive force in plants, by A. B. Plowman, is published in the *American Journal of Science* for February.

No. 18 of Dr. Holm's Studies in the Cyperaceae, dealing with *Carex fusca* and *C. bipartita*, is published in the *American Journal of Science* for February.

Among other interesting botanical articles in Volume XXXV of the *Journal and Proceedings of the Royal Society of New South Wales* is one on the relation between leaf venation and the presence of certain chemical constituents in the oils of the Eucalypts, by R. T. Baker and H. G. Smith.

A conspectus of the flora of Greece, by E. De Halacsy, — in the form of a two-volume octavo, — has recently been issued from the Engelmann press of Leipsic.

A good plate of detailed figures of *Prunus besseyi* is contained in Volume III, Fascicle 7, of the *Icones Selectæ Horti Thenensis.*

Under the editorship of Professor Sargent a new serial entitled *Trees and Shrubs*, devoted to illustrations of new or little known ligneous plants, prepared chiefly from material at the Arnold Arboretum of Harvard University, has been launched from the press of Houghton, Mifflin and Company. The first part, issued November 26, 1902, contains in addition to other things a considerable number of new species of Cratægus not included in the Silva, and a new genus of Scrophulariaceæ Faxonanthus, with a single species, *F. pringlei* Greenm. In form and typography *Trees and Shrubs* agrees with Professor Sargent's *Silva of North America*, and the plates are as in

that work from drawings by Mr. Faxon, which, however, are photo-mechanically reproduced.

The *Plant World* for February contains the following articles: — Safford, "Extracts from the Note-book of a Naturalist on the Island of Guam,— III."; Hastings, "Notes on the Flora of Central Chile"; Rowlee, "Conditions of Plant Growth on the Isle of Pines"; and Maxon, "A Botanist's Mecca [Chittenango Falls, N. Y.]."

The *Bulletin of the Southern California Academy of Sciences*, of January 1st, contains the conclusion of the botanical portion of Dr. Yates' "Prehistoric California," an article by S. B. Parish on certain California trees, and a second addition to the flora of Los Angeles County, by Abrams.

The *American Botanist*, (a popular journal) for January, contains the following articles: — W. W. Bailey, "Bark"; A. A. Field, "*Cereus giganteus*"; W. A. Terry, "Partridge Berries and Winter-green Berries"; and, W. N. Clute, "The Scouring Rush in Winter."

A revision of the described North American species of Leptochloa, by Hitchcock, constitutes *Bulletin 33 of the Bureau of Plant Industry of the Department of Agriculture.*

Data on the rapidity of growth of *Populus grandidentata* are given in *Forest Leaves* for February.

The appearance of Volume II, Fascicle 3, of *Coste's Flore descriptive et illustrée de la France*, etc., gives occasion to once more call attention to an admirably executed flora, with thumbnail habit and detail illustrations of all of the species included. T.

CORRESPONDENCE.

To the Editor of the American Naturalist:

SIR: Dr. T. D. A. Cockerell calls my attention to the fact that two generic names of fishes used in Jordan & Evermann's Fishes of North America have been earlier used in a generic sense.

The first is Falcula Jordan & Snyder, *Bull. U. S. Fish Comm.* for 1899, p. 124 (1900) type *F. chapalæ.* For this genus of Mexican Cyprinidæ, we suggest the new name of Falcularius Jordan & Snyder. Falcula Conrad, *Amer. Journ. Conch.* VI, p. 77, is an earlier genus of mollusks.

The second is Xenochirus Gilbert, *Proc. U. S. Nat. Mus.* XIII, 1890, p. 90, a genus of Agonidæ. The same name, Xenochirus, was used by Gloger in 1842, for a genus of Mammals.

As a substitute for Xenochirus, Dr. Gilbert proposes the new name, Xeneretmus Gilbert. The type of Xeneretmus is *Xenochirus triacanthus* Gilbert. There is also a genus Xenochira (Huswell, 1879) but that name being spelled differently from Xenochirus, is sufficiently distinct.

D. S. JORDAN.

QUARTERLY RECORD OF GIFTS, APPOINTMENTS, RETIREMENTS AND DEATHS.

EDUCATIONAL GIFTS.

Atlantic City, N. J., $60,000 for a library from Andrew Carnegie.

Barnard College, $1,000,000, from an anonymous donor for the purchase of additional land.

Bates College, $10,000 by the will of Ario Wentworth.

Boston Society of Natural History, $20,000 from the estate of the late R. C. Billings.

Brooklyn Institute of Arts and Sciences, $50,000 from Robert E. Woodward.

Brown University, $5000 from Edgar L. Marston for a scholarship.

Colby College (Maine), $5000 by the will of Robert O. Fuller.

Colgate University, $100,000 from Jas. B. Colgate.

Columbia University, $10,000 for a scholarship by the will of Mrs. E. J. Bowker; $100,000 from the Duke of Loubat for a chair of American Archæology.

Cornell University, $150,000 from an anonymous donor for a pension fund.

College of Physicians in Philadelphia, a conditional gift of $50,000 from Andrew Carnegie; $10,000 from F. W. Vanderbilt and $5000 from Clement A. Griscom for library purposes.

Dartmouth College, $5000 by the will of Professor Sylvester Waterhouse.

Davenport Academy of Science, the estate of the late Mrs. Chas. E. Putnam. including $24,000 for a publication fund.

Denison College (Ohio), a conditional gift of $60,000 from John D. Rockefeller.

Harvard University, $50,000 by the will of Rebecca C. Ames; $5000 by the will of Professor Sylvester Waterhouse; $5000 from Mrs. John Markoe for a scholarship.

Hobart College, $5000 from Mrs. Vail.

Johns Hopkins University, $5000 from R. B. Keyser for plans for improving the new site of the University.

Massachusetts Institute of Technology, $100,000 by the will of Ario Wentworth.

Oberlin College, $50,000 from an anonymous donor.

Rochester Athenæum and Mechanics Institute, $50,000 by the will of Mrs. Susan Brevies.

Rockefeller Institute for Medical Research, $1,000,000 from John D. Rockefeller for land and buildings.

Vassar College $8,000 by the will of Dr. Elizabeth L. McMahon.

Washington University (St. Louis) $25,000 by the will of Professor Sylvester Waterhouse.

Western Reserve University, $100,000 from Andrew Carnegie for a library training school.

APPOINTMENTS.

Elmer D. Ball, professor of zoöbiology in the Utah Agricultural College.— Dr. Joseph Barrell, assistant professor of geology in Yale University.— Dr. Richard Beck, professor extraordinary of economic entomology in the veterinary school at Tharandt, Germany.— Dr. Maurice A. Bigelow, adjunct professor of biology in Teachers College, New York City.— Dr. Pierro Marcellin Boule, professor of paleontology in the Paris Museum of Natural History.— Dr. Hermann Braun, professor of zoölogy in the veterinary school at Tharandt, Germany.— Dr. Cavallie, professor of anatomy in the school of medicine at Clermont-Ferrand. — Stewart Culin, curator of ethnology in the museum of the Brooklyn Institute of Arts and Sciences. — Dr. D. J. Cunningham of Dublin, professor of anatomy in the University of Edinburgh.— Bruce Fink, professor of botany in Iowa College.— Dr. Eugen von Daday, professor of zoölogy in the Hungarian Polytechnicium at Budapest.— Joseph Burtt Davy of California, state agrostologist and botanist to the Department of Agriculture in the Transvaal.— Dr. Giovanni Battista DeToni, professor of botany in the University of Modena.— Dr. James J. Dobbie, director of the Museum of Science and Art, Edinburgh. — Dr. Livingston Farrand, professor of anthropology in Columbia University and assistant curator of ethnology in the American Museum of Natural History, New York.— Dr. Otto Frank, professor extraordinary of physiology in the University at Munich.— Dr. Friedrich Richard Fuchs, docent for physiology in the University at Erlangen.— Dr. Frederick DeForest Heald, adjunct professor of plant physiology and bacteriology in the University of Nebraska.—Dr. Höflich, teacher of agricultural bacteriology and anatomy of domestic animals in the agricultural school at Weihenstephan. — Dr. F. von Huene, docent for geology and paleontology in the University at Tübingen.— C. W. Johnson, curator of the Boston Society of Natural History.— Prof. Franz Loewinson-Lessing, of Dorpat, professor of mineralogy and geology in the Polytechnic Institute at St. Petersburg.— Dr. Lubosch, docent for anatomy in the University at Jena.— Dr. Otto Maas, professor extraordinary of zoölogy in the University of Munich.— Margaret E. Maltby, adjunct professor of botany in Teachers College, New York.— Dr. Benjamin L. Miller, associate in geology in Bryn Mawr College.— Dr. Muth, docent for botany in the Karlsruhe technical school.— Dr. Friedrich Oltmauns, professor of botany in the University at Freiburg i. B.— Dr. A. E. Ortmann, of Princeton, curator of invertebrate zoölogy in the Carnegie Museum, Pittsburg.— Dr. K. Alfred Osann, professor extraordinary of

mineralogy in the University at Freiburg i. B.— Edmond Perrier, professor of comparative anatomy in the Paris Natural History Museum.— Dr. Porier, professor of anatomy in the medical faculty of the University of Paris.— Dr. W. H. C. Redeke, director of the zoölogical station at The Helder, Holland.— Mr. Gragg Richards, assistant in geology in the Massachusetts Institute of Technology.— Dr. H. M. Richards, adjunct professor of botany in Teachers College, N. Y.— Dr. Auguste Roude, assistant professor of anatomy in the University at Lausanne.— E. Dwight Sanderson, professor of entomology in the Texas Agricultural College.— M. H. Saville, professor of American archæology in Columbia University.— Dr. Arnold Spuler, professor extraordinary of anatomy in the University at Erlangen.— Walter Stahlberg, custodian of the museum of Oceanography in Berlin.— Dr. Fred. Wilhelm Richard Thomé of Jena, docent for anatomy in the University at Strassburg.— Dr. George Tischler, docent for botany in the University at Heidelberg.— Professor William Morton Wheeler, curator of invertebrate zoölogy in the American Museum of Natural History, New York.

RETIREMENTS.

Sir Michael Foster, from the chair of physiology in the University of Cambridge.— C. L. Greisbach, from the directorship of the Geological Survey of India.— Dr. Jaroslaus J. Jahn, from the chair of mineralogy in the Brunn Technical School.— Dr. Felix Kreutz, from the professorship of mineralogy in the University of Cracow.

DEATHS.

A. H. Chester, professor of chemistry and mineralogy in Rutgers College, April 12, aged 60.— François Desbois, student of orchids, in Brussels, Sept. 14, aged 75.— Dr. Hermann Dingler, professor of botany in the forestry school at Aschaffenburg, aged 55.— Major Alfred Fichlin, entomologist, in London.— Josef F. Freyn, student of plant geography at Smichow, near Prag.— Herbert D. Geldart, botanist, at Thorpe Hamlet near Norwich, England.— Dr. Franz Graeff, professor of mineralogy in the University at Freiburg i. B., aged 47.— Dr. Alexander W. M. van Hasselt, entomologist, in Amsterdam aged 88.— Dr. Paul Hautfeuille, professor of mineralogy in the Faculty of Sciences in Paris.— Dr. Gustav Herrich-Schäfer, botanist, at Ratisbon, January 21.— Charles P. Hobkirk, bryologist, in Ilkley, near Leeds, England.— E. A. Hudak, coleopterologist, in Gölwicz-bayna, Hungary.—Max Kossmann, coleopterologist, in December.— Dr. Leonhard Landois, professor of physiology in the University at Greifswald, aged 65.— Dr. Adrien Lemaire, student of diatoms and vegetable anatomy, in Nancy, Oct. 23.— Johann Lemberg, professor emeritus of mineralogy, in Dorpat Nov. 20, aged 60.— Gustav Limpricht, bryologist, in Breslau, Oct. 20, aged 68.— Reinhold Lohde, student of coleoptera, in Ber-

lin, January 6, aged 21.— Dr. Ernest Mehnert, professor of anatomy at the University at Halle, aged 65.— Louis Montillot, entomologist, in Montrouge, France, in December.— Dr. Heinrich Nitsche, professor of zoölogy in the Forestry School at Tharandt, Nov. 8.— Dr. Julius Pethö, chief of the Hungarian Geological Survey, at Budapest, Oct. 14, aged 55.— Dr. Wilhelm Pfitzner, professor of anatomy at the University at Strassburg, January 1, aged 49.— Luigi Pozzi, entomologist, in Modena, April 1, 1902.— Mrs. Charles E. Putnam, president of the Davenport Academy of Science, February 20, aged 70 years.— Gustav Raddi, director of the museum at Tiflis, Caucasus. — Oscar Lamarche de Rossius, lepidopterologist, in Hamoir, France, Sept. 7, aged 66.— Michael Schieferer, student of the leaf-mining Lepidoptera, at Graz, Styria, Mar. 31, 1902, aged 74.— S. Sirodot, professor of botany at Rennes.— Robert A. Sterndale, author of a work on Mammals of India and Ceylon, in St. Helena, Oct. 3.—Dr. A. J. Stuxberg, zoölogist and intendant of the museum at Göteborg, December 1.— Dr. Pierre Jules Tosquinet, entomologist, near Brussels, October 28, aged 78.—Dr. Woronine, professor of botany in the University at St. Petersburg, aged 79.— Dr. T. Zaaijer, professor of anatomy in the University at Leiden.

(No. 436 was mailed May 22nd.)